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Milling Buick Aluminum Crank-Cases

Edward K. Hammond

The enormous production of motor cars and the low prices at which they are now sold have been made possible by the use of machine tools of high efficiency and the provision of means for expediting the movement of the work from machine to machine. These conditions are exemplified in the Buick plant of the General Motors Co. in the machining of aluminum crank-cases. The cases are milled dry on special Ingersoll machines with cutter speeds ranging up to 600 feet per minute and feeds ranging up to 30 inches per minute. The highly developed milling machine practice and the automatic means provided for transporting the cases have greatly reduced the cost of production.

THERE is probably no industry in which more efficient equipments and methods are used for handling the work than in the manufacture of automobiles. The reason for this is that many automobile factories have been built and fully equipped for producing a large annual output of cars, according to designs worked out by experienced industrial engineers. In such cases, a higher rate of efficiency may naturally be expected than that attained in factories which have experienced a slow growth over a number of years, with the result that departments and equipment have been added from time to time, under conditions dictated by available floor space rather than by any preconceived idea of their relation to other departments in the factory.

It is the purpose of the present article to describe methods used in the Buick plant of the General Motors Co., at Flint, Mich., for milling aluminum crank-cases. The principal equipment consists of a battery of four planer type milling machines designed especially for this work by the Ingersoll Milling Machine Co., Rockford, Ill. These machines, together with the fixtures used on them, will be described in detail; and the information concerning the method of handling the work will also include a description of the machining operations performed on other types of machines, which come between the milling operations.

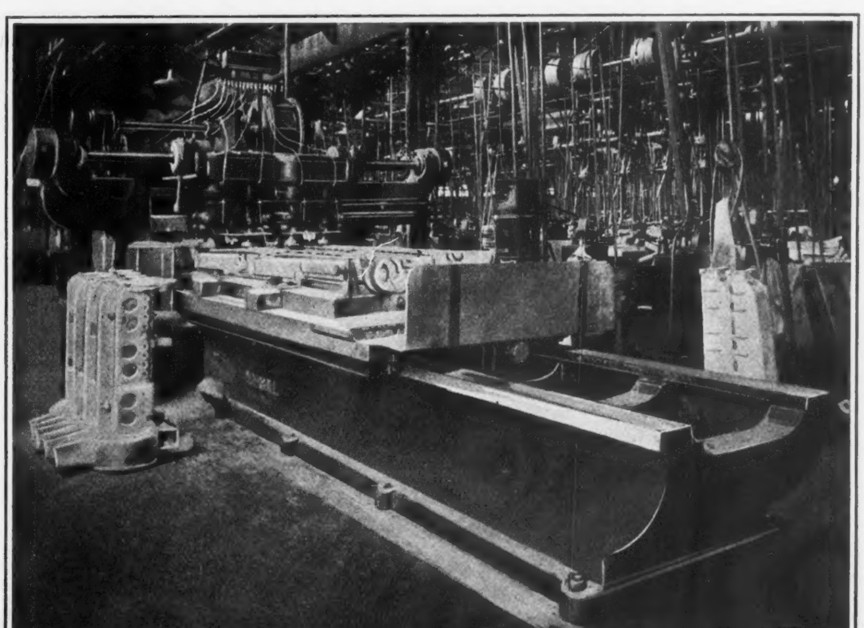

Fig. 1. Ingersoll Planer Type of Milling Machine on which First Operation is performed on Crank-cases

Ingersoll Milling Machines and Fixtures

Each of the Ingersoll milling machines is equipped with fixtures for holding five complete crank-cases, *i. e.*, five upper and lower halves and, in this connection, it may be mentioned that all the fixtures used on these machines were also designed and built by the Ingersoll Milling Machine Co. The machines are of the fixed cross-rail

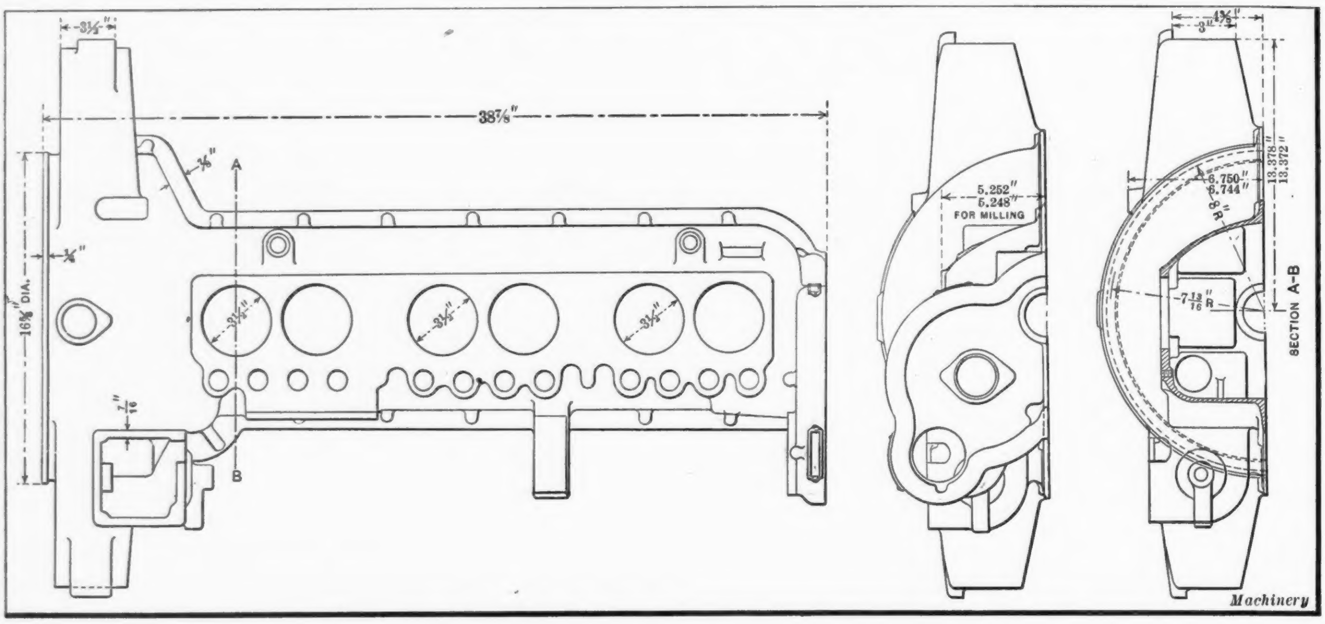

Fig. 2. Design of Upper Half of Crank-case for Buick Motor Car

type, the cross-rail being cast integral with the housings. The drive is provided by a 25-horsepower motor mounted on top of the housings, and the table is driven by a spiral rack and pinion. Continuous lubrication is provided for all bearings on the machine by means of oil-tubes which carry the lubricant by gravity from a reservoir located at the top of the housings. There is a similar reservoir on the side of the machine, from which tubes carry a continuous supply of oil to the feed change-gears. The table bearings on the bed are lubricated from oil-pockets cast at each end of the table. Provision for holding the work on the machine is made by means of six longitudinal T-slots which are supplemented by a liberal number of pin-holes.

Both hand and power feed of the work to the cutters are provided, the maximum power feed being at the rate of 30 inches per minute. There are twelve changes of feed for each change of cutter speed. The position of the vertical saddles on the rail may be adjusted by hand, and the horizontal saddles on the housings are also provided with vertical hand adjustment. The spindles are made of forged steel, and they are $4\frac{1}{2}$ inches in diameter; motion is transmitted to the outside vertical spindles by bevel gears which take power from a horizontal driving shaft on the rail, while the intermediate spindles are driven from the outer spindles by means of spur gears. The available spindle speeds range from $17\frac{1}{2}$ to 75 revolutions per minute, when the drive is provided by a 2 to 1 variable-speed motor. Two arbor supports are provided on each of the housings, and these supports have both vertical and lateral adjustment.

Arrangement of the Machines in the Factory

The machines are set up end to end and occupy one complete bay in the motor factory. The aluminum castings to be machined are brought to the milling department and the upper halves of the crank-cases are stacked at one side, while the lower halves are placed at the opposite side of the first milling machine, at a point just in front of the housings. Two operators are employed at each machine, and as the work passes out from under the cutters, one man stands at each side of the moving table, releases the work from the fixtures and

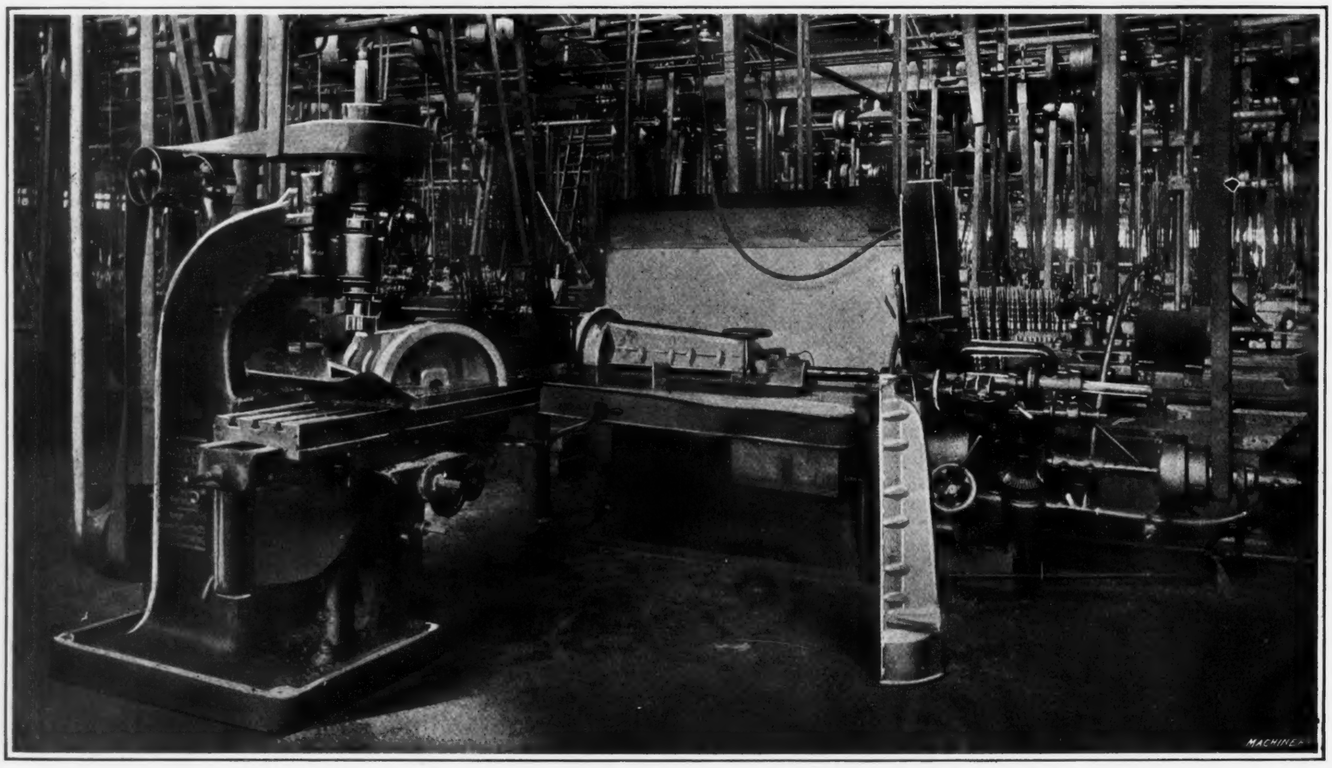

Fig. 3. Boring Shaft Bearing and facing off Oil Pump Pad

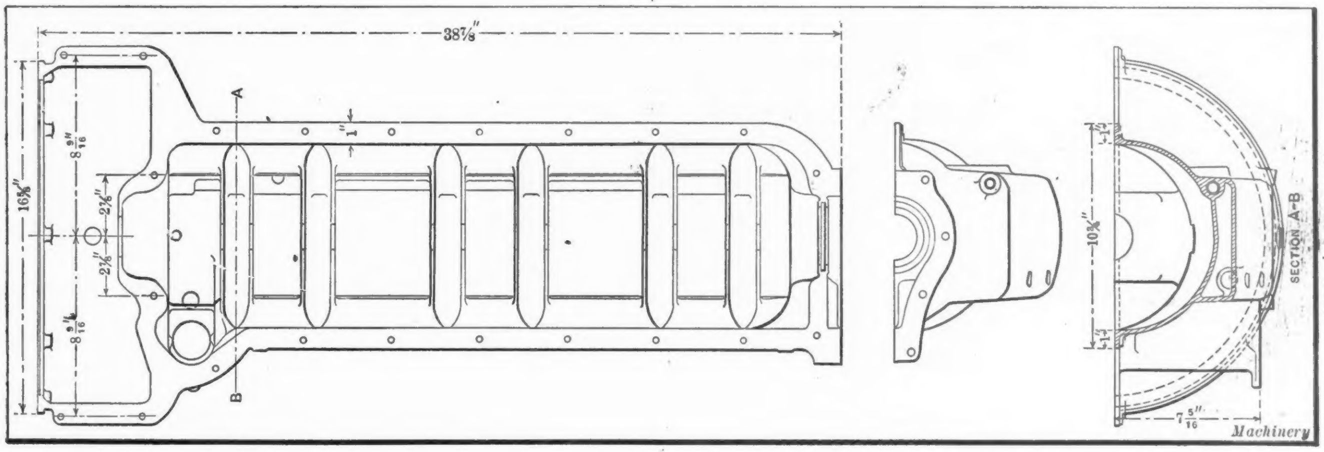

Fig. 4. Design of Lower Half of Crank-case for Buick Motor Car

removes it. After all the pieces have been taken out in this way and the table starts on its return motion, the operators go to the front of the housings where the accumulation of castings has been placed ready for them, and these castings are put in position in the fixtures as the table moves back. No attempt is made to clamp the work in the fixtures at this time, however; the clamping is done as the table moves forward to bring the work up to the milling cutters.

The arrangement will probably be better understood by referring to Figs. 1 and 6, which show general views of two complete milling machines. Fig. 1 shows the machine on which the first milling operation is performed, and in this illustration a number of castings will be noticed standing on the floor just in front of the housings. These castings will be set up in the fixture as the table comes back preparatory to taking the next cut. To facilitate handling, gravity conveyors are provided between the machines, and as the work is removed from the fixtures it is lifted directly onto these conveyors which take it to the machine on which the subsequent operation is performed. This makes it unnecessary for the operators to stoop in setting down the work, and saves them from excessive fatigue. As a result, there is no slowing down of the rate of production from this cause. A section of one of these conveyors is shown in Fig. 5, from which it will be seen to be of the gravity-roller type. The same system of conveyors is employed between all machines in the milling department, so that the amount of labor involved in transporting the work from machine to machine amounts to practically nothing.

Referring again to Fig. 1, which shows the machine on which the first milling operation is performed, it will be seen that the crank-case castings are set end to end on the table. On this machine, there are four vertical spindles on the rail, but no horizontal spindles carried by saddles on the housings; the work performed consists of rough-milling the connecting surfaces between the upper and lower halves of the crank-cases. The two cutters which work on the same casting rotate in opposite directions, the purpose being to neutralize all strains and reduce the possibility of the work being forced out of position. The milling cutters employed for this purpose are of the inserted-tooth type; formerly, high-speed steel cutters were used, but the excessively high cost of high-speed steel at the present time led to experiments being conducted with different brands of carbon steel, and it was found that by using cutters made of Jessop carbon tool steel, very satisfactory results could be obtained. The depth of cut is about 3/32

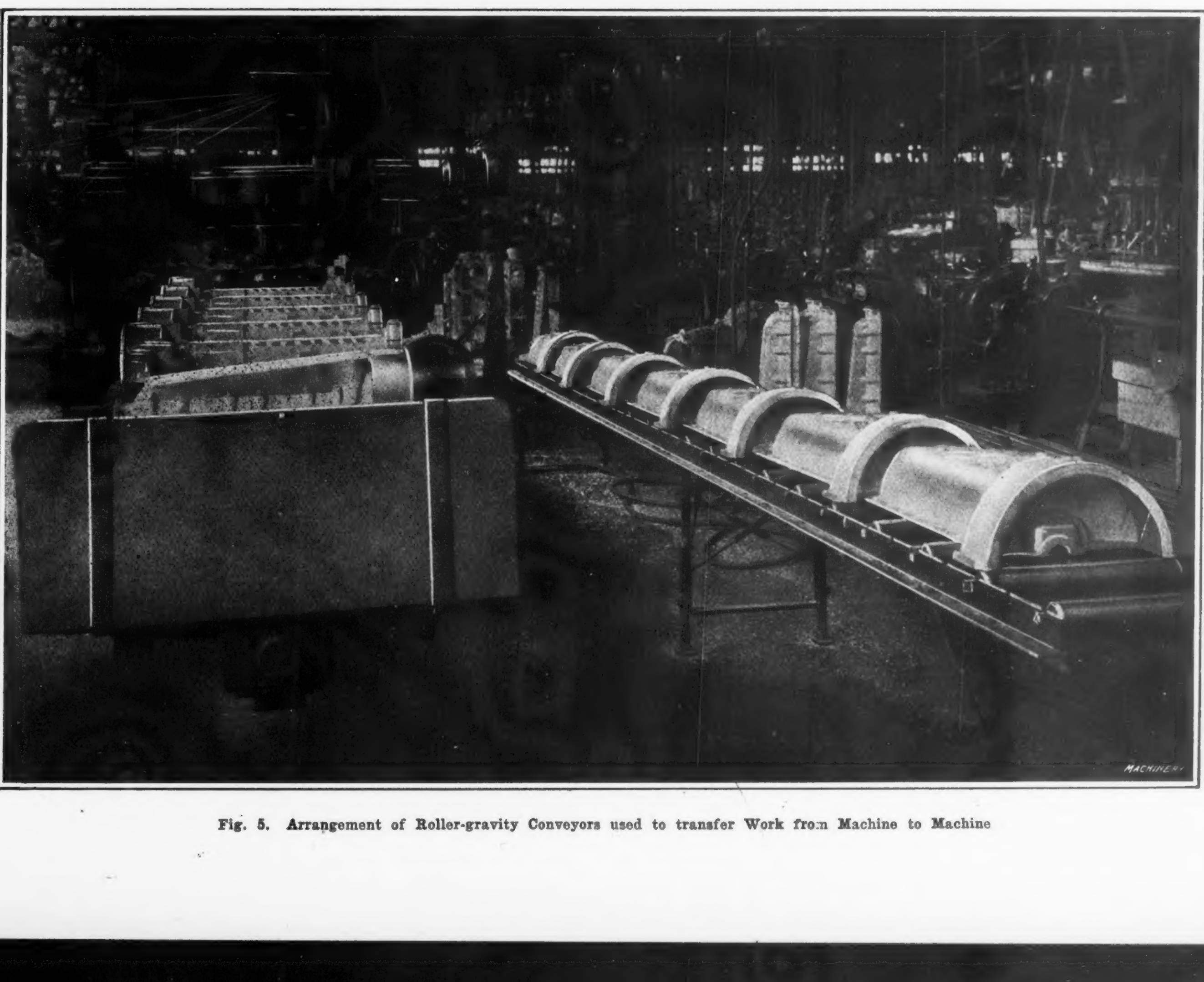

Fig. 5. Arrangement of Roller-gravity Conveyors used to transfer Work from Machine to Machine

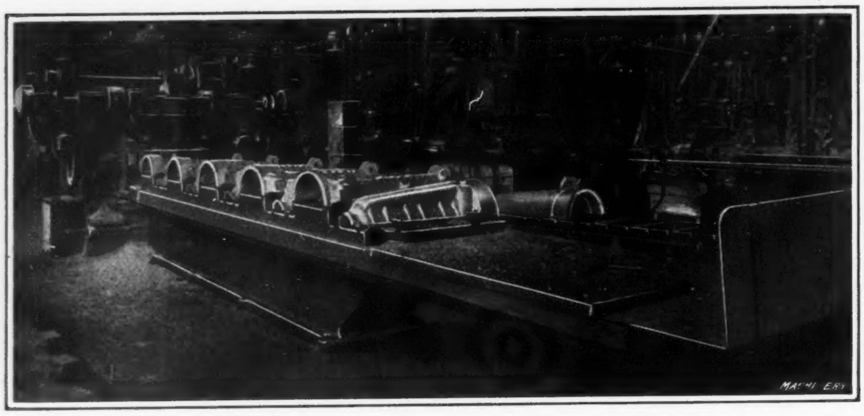

Fig. 6. Same Type of Machine as that shown in Fig. 1, but equipped with Fixtures set transversely across Table

inch and the work is fed to the cutters at a rate of 29 inches per minute. The peripheral speed of the cutters is 600 feet per minute.

It was formerly the practice of the General Motors Co. to use a cutting compound in milling these aluminum crank-cases, but trouble was experienced from water being thrown from the large cutters that are employed, and when the matter of obtaining new machines for the work was taken up with the

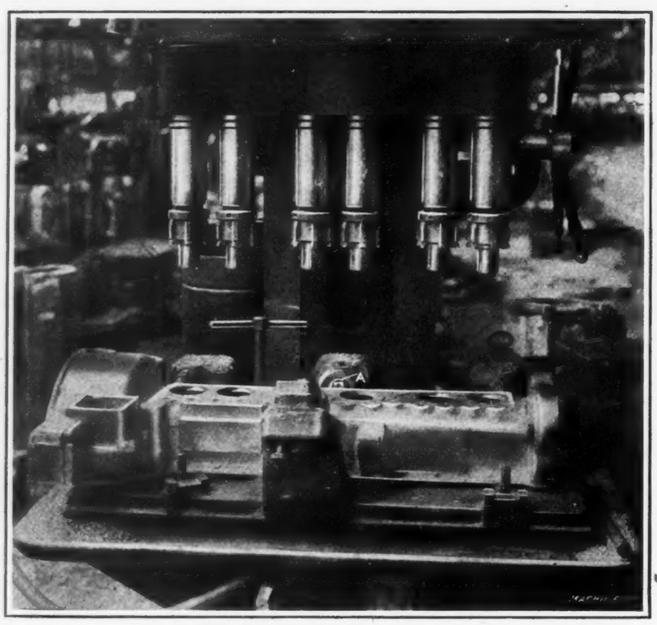

Fig. 7. Foote-Burt Boring Machine on which Cylinder Holes are machined in Upper Halves of Crank-cases

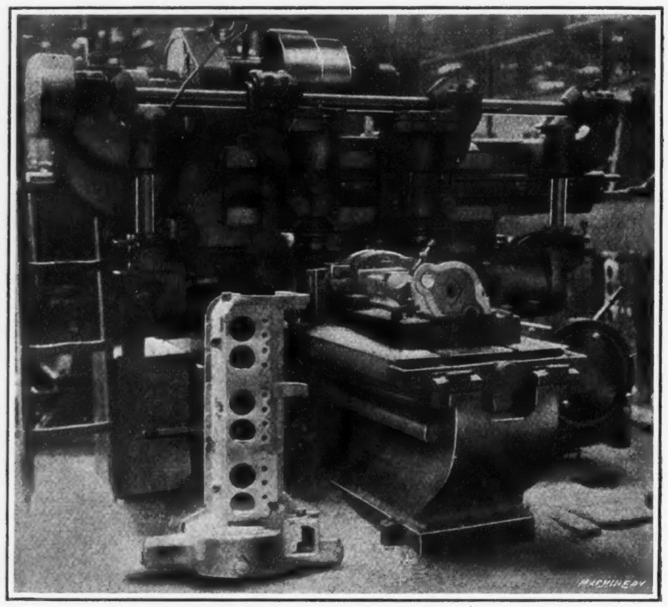

Fig. 8. Small Ingersoll Milling Machine used for facing Suspension Arms, Starter Box Seat and Accelerator Pad

Ingersoll Milling Machine Co. this firm recommended that the work be done dry. Milling without the use of any cutting compound was adopted at the time the new machines were put in operation, and the results obtained have been entirely satisfactory. The rate of production is twenty-two upper and twenty-two lower halves of the crank-cases per hour.

A close view of two pairs of fixtures of the type used on the first machine is shown in Fig. 9, where it will be seen that the upper and lower halves of a crank-case are set up in one pair of fixtures, while the other pair is empty in order to show the construction more clearly. These fixtures are designed to provide a three-point suspension support for the work. The lower halves of the crank-cases, which are carried in the fixtures at the far side of the machine, are supported by two pivoted brackets *A*, which engage the under side of the flanges, and a third support which contacts with the bottom of the crank-case, this support being located inside the fixture at the opposite end from the brackets *A*. Additional support is provided by spring pins *B* which engage the casting along the under side of the flanges at each side. The work is secured in the fixture by clamp screws which grip each side of the casting and are supplemented by hold-down straps on each fixture, one of which is shown at *C*.

The upper halves of the crank-cases are held in the fixtures at the near side of the machine. Here, again, the three-point suspension principle is employed for locating the work in the fixtures; at the flywheel housing end, the casting is engaged by the stop *D*, while the third suspension point *E* contacts with the bottom of the casting at the gear-case end. Further support is furnished by spring pins *F* which adjust themselves to engage the flange at each side of the casting. The work is clamped in the fixture by means of binding screws which are tightened at *G*, and held down by studs projecting up through the cylinder holes. Slotted plates (one of which is shown at *H*) are provided for use on these studs so that the time required to tighten them is reduced as far as possible.

The second operation is performed on the upper halves of the crank-cases, which are transferred from the first milling machine to a six-spindle Foote-Burt boring machine that bores out all the cylinder holes at a single setting. The machine used for this purpose is shown in Fig. 7; pads are provided on the fixture which support the work from the finished face of the flange, and the longitudinal position is governed by means of a slot *A* which engages a small vee cast on the work for that purpose. Two bosses at each end of the casting engage pads on the fixture and govern the sidewise location of the work. The casting is clamped down by means of suitable straps which hold it by the flange. This machine is operated at a feed of approximately 0.020 inch per revolution, and a cutter speed of 350 feet per minute; the depth of cut is 3/32

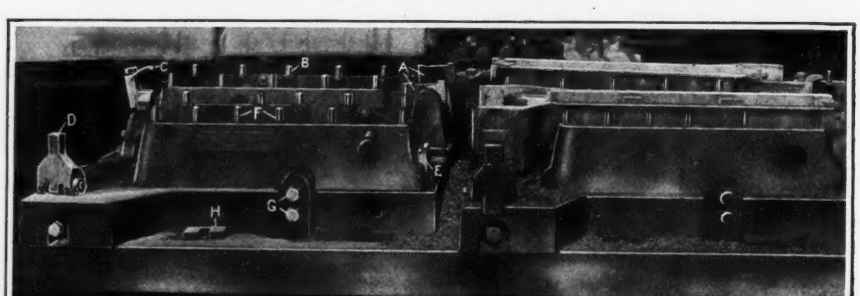

Fig. 9. Close View of Fixtures in which Work is held for First Operation

inch. The machine is more than able to keep up with the rate of production obtained on the preceding milling operation.

The lower halves of the crank-cases go direct from the first to the second Ingersoll milling machine, and the upper halves go onto the same machine from the Foote-Burt boring machine on which the second operation is performed. This machine is shown in Fig. 6 and is employed for the purpose of rough-milling the top surface of the upper half of each crank-case, and for taking a roughing cut on the end of the gear-case and on the end of the flywheel housing on both the upper and lower halves of the crank-case. It will be seen that the machine used for this purpose is provided with five spindles, there being three vertical spindles carried by saddles on the rail, and a horizontal spindle at each side of the machine carried by saddles on the housings. The three vertical spindles perform the facing operation on the top of the crank-case, and the horizontal spindles face the end of the gear-case and the end of the flywheel housing.

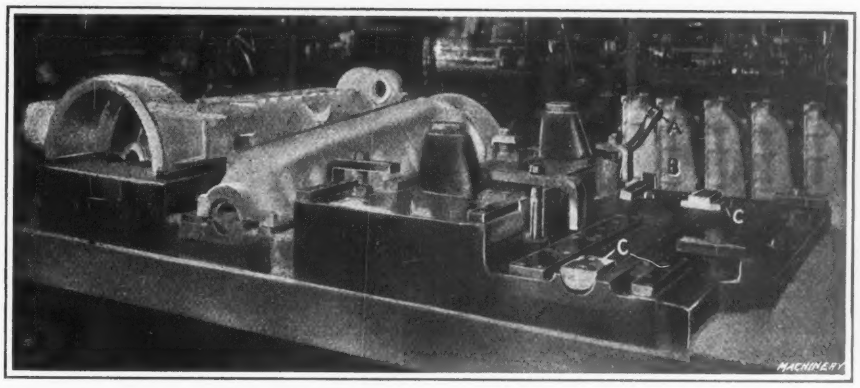

Fig. 12. Milling Machine and Fixtures used for taking Finishing Cut over End of Gear-case and Top of Crank-case

A close view of the fixtures provided on the machine is shown in Fig. 11, where it will be seen that pads A are provided to support the work from the finished faces of the flanges that were milled during the first operation. The upper halves of the crank-cases are located from the cylinder holes by means of plugs B on the fixtures, while the lower halves of the cases are located by means of the vee cast on the work, which fits into notches C on the fixtures, and by bosses cast at the opposite side of the work which are engaged by stops D. The method by which the work is strapped down on the fixture will be readily seen by referring to the illustration, but attention is called to the fact that each pair of straps holds two castings, so that the time required to clamp the work is reduced to a minimum. The cutters are set up on the machine by means of positive locating blocks, and fine adjustment is obtained by a dial test indicator. The work is fed to the cutters at a rate of 23 inches per minute, and the peripheral cutting speed of the cutters is 600 feet per minute. The depth of cut is 3/32 inch.

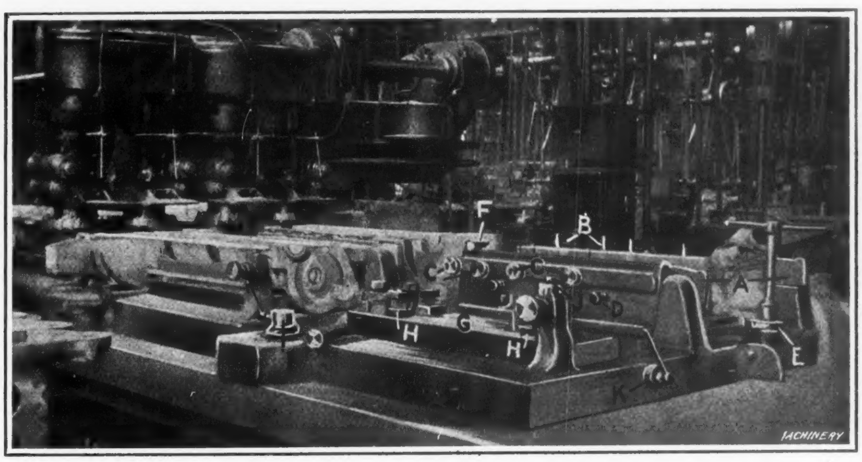

Fig. 10. Milling Machine and Fixtures used for taking Finishing Cut over Flanges

The fourth operation, which is performed on the third large Ingersoll milling machine, consists of taking a finishing cut on the faces of the flanges. The fixtures employed for this purpose are shown in Fig. 10, from which it will be seen that they are of the same design as those employed for the first operation, but in the present case, the operation of the fixtures is more sensitive. The lower halves of the cases are held by a three-point suspension (two points shown at A) and further supported by spring pins B which engage the flanges at each side. The arrangement is essentially the same as that explained for the corresponding fixture for the first operation, except that the spring pins B are adjusted by independent screws C, which gives a more uniform support to the work than is the case where all of the pins are controlled by a single screw. The work is held down in the fixture by four independent screws D which engage the sides of the crank-cases, and by two straps E and F which engage each end of the work.

The upper halves of the cases are located by pads G from the milled upper faces of the work, and by plugs H which enter the cylinder holes. Two spring pins I engage the work under the flywheel housing, and two pins J and K help to support the casting at the opposite end. The work is held down in the fixtures by means of straps on the plugs H which extend up through the cylinder holes. The depth of cut taken is about 0.025 inch and the cutting speed and feed are the same as for the first operation, *i. e.*, the feed is 29 inches per minute and the peripheral cutter speed, 600 feet per minute. After the work is removed from the fixtures, it is transferred to a surface plate and tested with tissue-paper feelers 0.003 inch in thickness to insure an accurate fit between the upper and lower halves of the crank-cases when assembled.

The fifth and sixth operations are performed on the lower halves of the crank-cases. In the fifth operation, the work is set up on a Barnes horizontal drill press, shown in Fig. 3, where the crankshaft bearing is bored. The fixture provided on this machine locates the work by means of two pads which engage the same bosses on the castings that were used in the second and third operations; and the longitudinal position of the work in the fixture is determined by the vee on the casting which engages a notch on the fixture. The work is held down by means of two straps and a clamping screw. While the boring operation is being performed on one case, the case in which the bearing has just been bored is set up on a No. 5 Becker vertical milling machine, which is also shown in Fig. 3, and the pad for the oil pump is faced off. The fixture used on this machine is very simple, consisting merely of a flat plate to

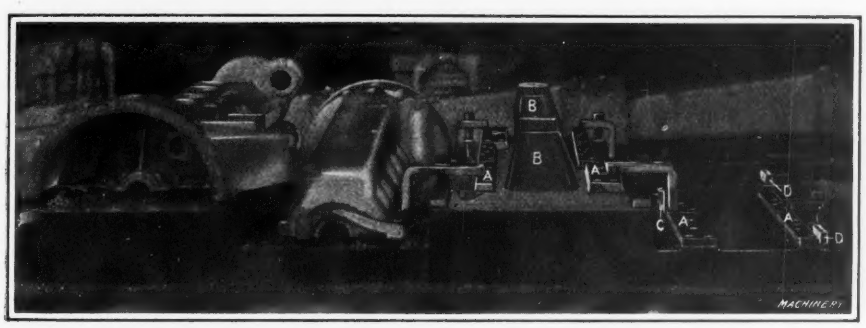

Fig. 11. Fixtures used to hold Work while milling Top Face of Crank-case and Ends of Flywheel Housing and Gear-case

which the work is strapped down. The machine is equipped with an automatic trip to disengage the feed after the milling operation has been completed. One operator is able to attend to these two machines and secure a rate of production equal to the rate at which the crank-cases are turned out by the milling machine on which the preceding operation was performed. On both the Barnes and Becker machines, the work is lubricated with water.

In the seventh operation, the lower halves of the crank-cases are finish-milled on the gear-case end, and the upper halves of the cases are finish-milled on the top to a limit of accuracy of 0.002 inch, and also finish-milled on the gear-case end. The equipment used for this purpose is shown in Fig. 12, where it will be seen that the fixtures for holding the upper halves of the crank-cases are essentially the same as those employed for the third operation, except that a support A is provided to support the gear-case end of the work and eliminate chatter. The fixtures used for holding the lower halves of the crank-cases are of a different design from any that have formerly been employed. In this case, the work is located by stops B engaging the end of the flywheel housing which was rough-milled in the third operation, and by plugs C which enter the bored bearing in the crank-case. After being milled on this machine, the top surface of the upper halves of the crank-cases are tested for accuracy with a straightedge, and the surface of the flange is tested with tissue-paper feelers 0.002 inch in thickness. The distance between the finished surfaces on opposite sides of the upper halves of the cases is measured with a micrometer and must be accurate within a limit of 0.004 inch.

After being subjected to this inspection, the work is taken to a four-spindle Ingersoll milling machine, of smaller size than the ones previously used, on which the arms are faced off for the three-point suspension mounting of the crank-case on the frame; this machine also mills the face of the seat for the starter gear-box and the accelerator pad. It is shown in operation in Fig. 8. The work is done dry and the rate of feed is 20 inches per minute, with a peripheral cutter speed of 500 feet per minute. The depth of the cut is about 3/16 inch, and the work is located by two plugs on the fixture which enter the cylinder holes. The final milling operations are performed by a battery of five No. 3 millers shown in the heading illustration, equipped with fixtures which locate the work from the cylinder holes in all cases. These machines perform a collection of miscellaneous operations; the operation of milling and the fixtures are quite simple, so that a detailed description would be of little interest.

This article is not intended to be a complete exposition of the machining operations involved in the manufacture of Buick crank-cases. The idea has been threefold: first, to present a brief description of machines and fixtures employed for this work which embody principles that are applicable for many other milling operations; second, to point out the labor-saving methods used for handling the work; and third, to show the exceptionally high rates of speed and feed which are obtainable in milling aluminum, and to point out the fact that this high rate of production is obtained without the use of any cutting compound. In an article of this kind, the value to the general reader is the possibility of employing similar methods in his own work; and if readers of MACHINERY find other applications for some of the principles of fixture design and methods of handling the work that have been described, the present article will have attained its object.

* * *

A German concern has brought out a new bearing metal known as "war bronze." The composition of this alloy, however, is not published. The war bronze is the result of experiments undertaken to produce a bearing metal which can be used as a substitute for alloys containing a high percentage of copper, on which metal the German government has placed an embargo during the war. It is claimed that this war bronze can be used in all cases where brass, ordinary bronze, or phosphor-bronze would ordinarily be employed, and that it has been used with good results for bearings and worm-wheels for some time.

FORMULAS FOR COMBINED BENDING AND TORSION STRESSES

In an article in the *Sibley Journal of Engineering*, December, 1915, G. B. Upton deals in a very complete and concise manner with the different formulas that have been developed for the stresses in metals subjected to combined tensional, compressional and shearing stresses—that is, combined bending and torsion. The principle now accepted as true for beams or machine parts loaded so as to produce combined bending and torsion is known as "Guest's law," which states that in any case of single or combined loading the point where the elastic limit and the yield point is exceeded, is dependent upon the maximum shear stress exceeding a certain critical shear stress value. This critical shear stress value is only half the tension stress intensity at the tension yield point of the metal.

Guest's law was tested out experimentally only for a limited number of ductile metals. It is fairly obvious that it cannot apply at all to the brittle metals. As a hypothesis, Guest's law has to compete with two other hypotheses. The three hypotheses concerning the conditions at failure may be stated as follows:

1. Guest's. Failure occurs when the maximum shear stress in the piece of metal reaches a certain critical value.
2. Rankine's. Failure occurs when the maximum tension stress in the piece ("principal stress") reaches a certain critical value.
3. St. Venant's. Failure occurs when the maximum unit deformation in the piece reaches a certain critical value.

The comparison of the different criteria of failure may perhaps be made more evident by comparison of the resulting formulas for combined bending and torsion of a solid circular shaft.

1. Guest's:

$$q = \frac{16}{\pi D^3} \sqrt{M^2_b + M^2_t}$$

2. Rankine's:

$$p = \frac{16}{\pi D^3} \left(M_b + \sqrt{M^2_b + M^2_t} \right)$$

3. St. Venant's:

$$p = \frac{16}{\pi D^3} \left(0.7 M_b + 1.3 \sqrt{M^2_b + M^2_t} \right)$$

In the above formulas,

q = shear stress intensity;
p = tension stress intensity;
D = outside diameter of shaft;
M_b and M_t are, respectively, the bending and torsion moments.

It is obvious that the three formulas will not give the same solution for D. Rankine's and St. Venant's formulas are fairly similar; Guest's differs radically from the other two.

The opinion of the writer of the article abstracted, as to the applicability of the three criteria of failure, has been formed partly from the results of the experimental work noted above, and partly from recent work in the Sibley College laboratories. For the fully ductile metals, which have a yield point in tension testing, and break with a cup and cone break under tension, Guest's law is probably true not only at the yield points in the various loadings, or in combined loadings, but also at the break. For the semi-ductile metals, which have a tension yield point, but finish in tension testing with the square break of pure tension, Guest's law determines yield points and Rankine's law determines breaks (if tension break is possible under the system of loading applied). For the brittle metals there are usually no yield points (certainly not in tension), and Rankine's law determines tension breaks. In the compression of brittle metals, Guest's law determines yield points, if there are any, and also determines breaks, if they are due to shear. St. Venant's law does not apply anywhere. The determinant of failure is always a stress, not a deformation. All yield points are determined by a shear stress; and all breaks are determined either by a shear or by a tension stress.

LATHE CHUCKS—1

A REVIEW OF FACEPLATE AND COLLET WORK-HOLDERS

BY JOSEPH HORNER*

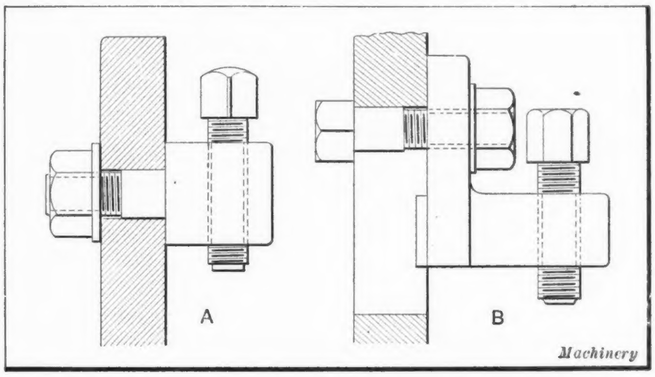

Fig. 1. Simple Screw Dogs on Faceplate

THE potter's wheel is obviously the clue to the origin of lathe chucks, and its simple form is still representative of the great group of face chucks. The only essential difference is that in the latter a precise means of obtaining a frictional hold upon the work is provided in the form of jaws or other devices, necessitated by the nature of turning. The fact that a large proportion of turned work has to be steadied or supported upon an extraneous center does not alter the principle, since the chuck is always the driving agent. The earliest types of lathes comprised nothing more than a couple of centers held in uprights driven in the ground, and the work was rotated with a cord. At this time no kind of chuck was used, but the abandonment of the cord drive brought about the necessity for a driver or chuck, and upon the advent of the handwheel, footwheel and power agency for driving the lathe, regular chucks were developed. At the present day it is bewildering to attempt to grasp the immense variety of chucks in use. Even during the last five years or so their ranks have received great accretions on account of the increasing

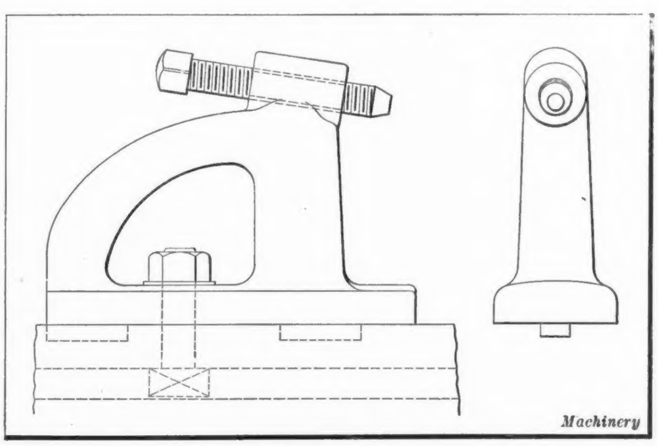

Fig. 2. Dog for Use on Boring Mill Table

practice of using special chucks for gripping repetition work, particularly in automobile manufacture. In addition to specialized shapes of jaws, the chucks often include seatings or abutments for the purpose of support or precise location of the object, and holes for the reception of pilots on tools.

Apart from this growing specialization in chuck design, the chief point which differentiates modern types from those of, say, a decade since is that of enhanced strength. In the majority of cases standard designs have been made heavier. In other cases new designs have been evolved to meet the greater strains produced in dealing with high-speed work. Chucks with steel instead of cast-iron bodies are now largely used. The use of auxiliary screw dogs or serrated jaws is noticeable in many instances as a help to the frictional drive of the standard jaws. There is difficulty in dealing with classes of work which are liable to distortion through pressure wrongly applied. In such cases it may be impracticable to exercise any great force in clamping, because the work will assume a distorted form, and will spring back to its original outline upon being released from the chuck. This, of course, would give detrimental and uncertain results. The employment of driving pins or flanges solves the difficulty in some shapes, these drivers rotating the piece against the stress of cutting. When it is not feasible to introduce driving pins or flanges, a considerable amount of thought and care may have to be exercised in designing the chuck or its jaws. Sometimes, even, the selection of a safe mode of chucking alters the determination of the precise type of machine which the piece shall be machined upon.

Another question that must never be disregarded is whether the work will run in proper balance, and for this reason a good many objects are tooled while held in a fixed position

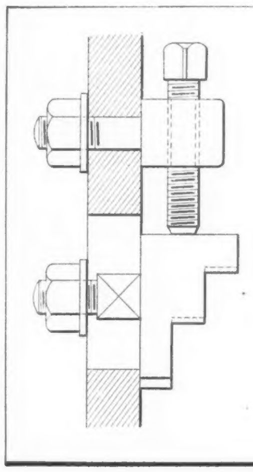

Fig. 3. Simple Dogs and Thrust Screw on Faceplate

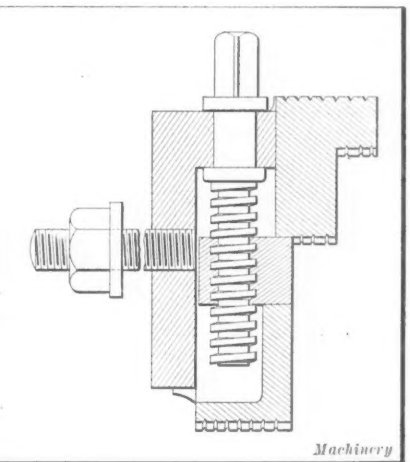

Fig. 4. Self-contained Faceplate Jaw

in preference to rotating them in a lathe. If work is repetitive the expense and time occupied in securing a proper balance by the use of a counterweight on the chuck is repaid, and if there are a number of operations that follow in succession and can be best done with tools from a turret, it is better to revolve the work and machine it in this fashion. A piece might be more easily gripped on a boring type of machine, without the need of balancing, since the piece remains stationary, but the time of changing tools in the boring spindle would make this method prohibitive.

The question of the relative number of parts to be machined usually determines the form of chuck which shall be used unless the work is of the plainest description. In the latter instance, an ordinary type of chuck with standard jaws is perhaps perfectly suitable. However, as soon as any complication in outline affecting chucking arises, it is necessary to devise a chuck, or make special jaws, which will facilitate gripping, lessen the time and eliminate all risk of inaccuracies. In a shop doing the ordinary run of miscellaneous work, the chucks will be all more or less standard, that is, modifications

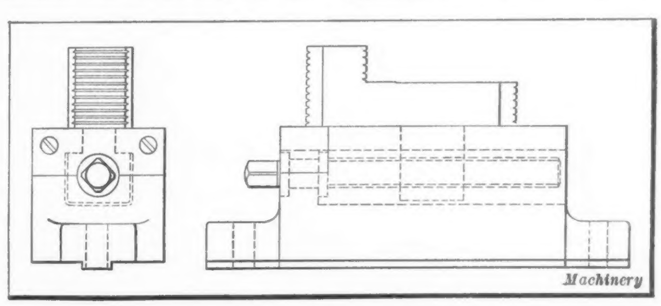

Fig. 5. Another Design of Self-contained Faceplate Jaw

* Address: 45 Sydney Bldg., Bath, England.

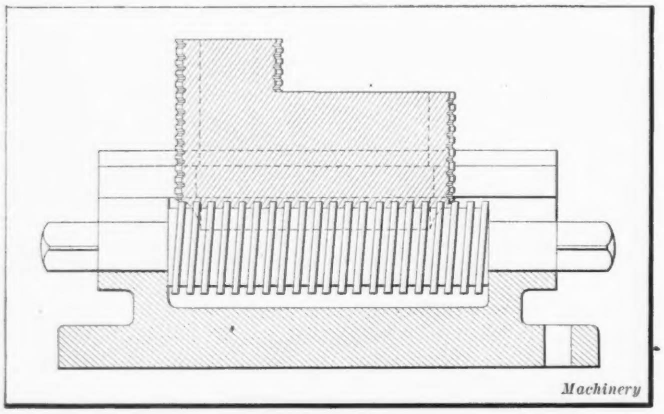

Fig. 6. Reversible Faceplate Jaw

of a special nature will not be very noticeable. But in a highly specialized shop the number of strange shapes encountered is remarkable, and any one of them picked out at random would probably be suitable only for the particular kind of work it is handling. Occasionally, however, a chuck is designed with a certain degree of adaptability to cover a range of holds, thereby saving expense and storage room. The addition of one or more fitments, or an adjustment obtained by placing screws or bolts in another set of holes is usually sufficient to meet requirements. Balance-weights also may have adjustability to two or three locations, placed accurately to suit the altered position of the same work or another piece of different size. The matter of whether a chuck shall be designed for one purpose only or for various uses is entirely dependent upon the number of pieces to be produced by it. The number of similar pieces to be produced affects the kind of chuck employed in a radical fashion, more particularly if the work is of moderate or small dimensions. In the latter case, a spring type of chuck frequently suits better than one with sliding jaws, and is easier to operate and more convenient in some respects. Special collets are necessary to fit the work, and it is generally a simpler matter to arrange these in a spring chuck than in one with sliding jaws. But when the dimensions of the object exceed the capacity of spring chucks, the matter is one for choice between a special chuck made to suit, and false jaws fitted to a chuck of standard design.

Faceplate, Dogs and Holding Devices

For the purpose of these articles, we shall take up the chucks where they begin, by the attachment of screw dogs to an ordinary faceplate, forming the primitive principle of gripping at the side of the work. At one time, turners had no other assistance than that of the faceplate with dogs of a more or less makeshift type, and such things as proper sliding jaws accurately fitted were unknown. The work was held by the ends of screws, but as cuts were light, and time was of little importance, there was not the same need for rapid and powerful means of holding that present-day requirements demand. Neither was there any self-centering principle available, and all work had to be adjusted tentatively. Even standard round shapes as drills and rods were held in bored chucks and clamped with screws—a method only met with now in the bell chucks. Though the method of using simple screws in dogs attached to a faceplate, as shown in Fig. 1, is still utilized largely among amateurs and to a lesser degree in the small shops, it is open to the objection of insecurity. The point or end of a screw affords only a small area, on which work is liable to swivel or skid. The surface, moreover, becomes impressed quickly, resulting in slackness while the turning or boring is in progress. With a jaw having three or more times the surface contact, these difficulties are greatly diminished, and it is practicable to hold with continuity of pressure from beginning to end with little or no risk of slipping out of position, unless the object is exceptionally shaped, tapered, or has excessive overhang. The only merits of the screw dog device are its cheapness, since an ordinary faceplate may be employed. Practically the only instance where the screws possess any advantage over proper jaws is their adaptability to reach into angles and recessed parts where space is limited. In a few cases it may be necessary to have unusually long screws, but generally quite short ones are employed, as in Fig. 1, since adjustments of more than a very short distance

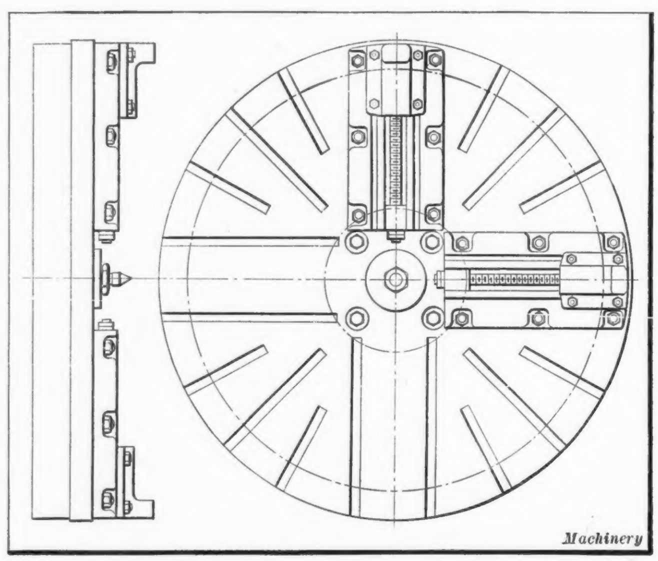

Fig. 8. Heavy Faceplate provided with Reversible Jaws

can be made by shifting the dog in its slot, or to another hole. The amount to which a screw is set out from the surface of the plate depends on the class of work being handled; it is usual to have a double set of dogs, one set with the screw laid closely in, as at *A*, Fig. 1, and the other with the dog lengthened to bring it further away, or made in the form of a miniature angle-plate *B*. It is not usual to set the screws at other than right angles to the axis of the dog, because the work is more likely to slip, but in the case of the horizontal tables of boring and turning mills, gravity helps to keep the object down, and it is then practicable to set the screws at a slight angle, pointing downward. The dog is either plain, like that shown at *A* or *B*, Fig. 1, or elaborated into a higher casting, Fig. 2, to reach some way up the work and resist tilting. Should the work be shallow, it can be packed up to make it come up to the range of the screws. Either three or four such dogs are utilized. Frequently they supplement the grip of the standard chuck jaws, the piece being first centered and gripped with these, and the screw dogs brought up afterward.

A makeshift compromise between the screw dog and the regular jaw is to push the one along with the other, as shown in Fig. 3. It is a clumsy device, however, and not easy to manipulate, while for diameters approaching that of the faceplate it cannot be employed. The neatest device is the self-contained jaw, Fig. 4, comprising a base bolted to the faceplate, a jaw sliding in vees on the base, and a screw passing

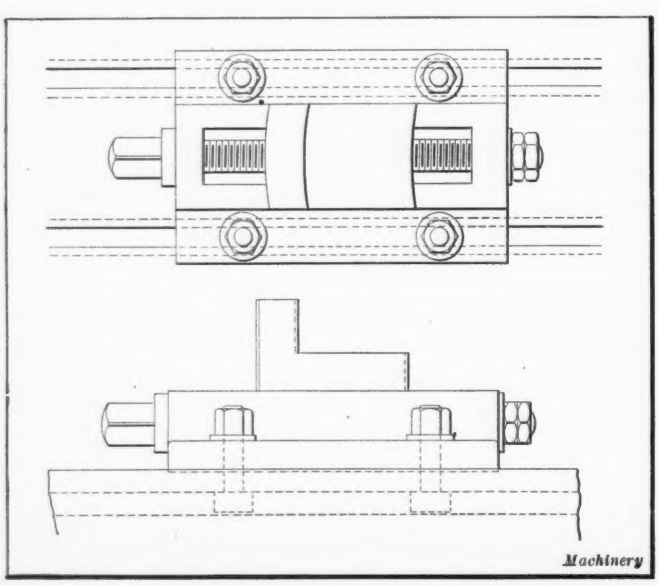

Fig. 7. Large Faceplate Jaw

through the nut which is let into the jaw. Stronger designs are illustrated in Figs. 5 and 6, the first with a screw of medium diameter retained by thrust collars, the other with a screw of more generous diameter, and a jaw which can be run out at either end for reversal. As large faceplates and boring-mill tables have double T-slots, it is necessary to modify the bases of the jaws accordingly, as in Fig. 7. The largest plates are fitted with bases of sufficient length, Fig. 8, to give the full range of travel to the jaws, thus obviating the necessity for adjusting the bases. They are only touched when removal is required, to leave the plate plain. In any type of jaw-fitting there is the disadvantage that the necessity for having a base makes the jaw stick out from the plate farther than when fitted direct to slots in the plate. A great many classes of objects, however, are secured with the help of bolts and clamps, supplementary to the grip of the jaws, so that the objection is not so important as it may seem.

A variety of special hooks or clamps is also used for certain work which is difficult to hold firmly, either on account of the small area available for gripping or because of a slight taper which tends to eject the piece when the vibration induced by cutting is set up. Fig. 9 shows a clamp combined with a jaw (for use in a tire-boring mill) especially to secure the tire firmly. The clamp is hinged to throw down out of the way. Another way in which part of the severe duty is taken from a set of jaws is that of adding one or more driver pins, set either directly in the faceplate, or into massive castings bolted thereto. These pins engage with arms or other projections, and afford a positive drive. Sometimes, also, when an extremely heavy cut has to be taken from a bar or shaft, the hold of ordinary jaws is supplemented by the application of three or four massive screw dogs, of the type shown at *A*, Fig. 1, which are very heavy and held with two or three bolts.

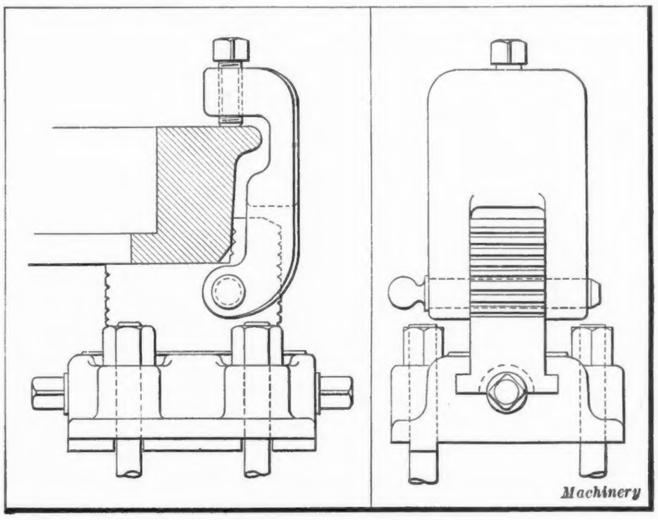

Fig. 9. Jaws with Pivoted Clamp

Independent-jaw Chuck

The standard independent-jaw chuck is directly related to the faceplate fitted with a set of loose jaws, the only difference being that the jaws are fitted directly into the plate and the screws are built in, as shown in Fig. 11. There is a good deal of variation in detail, especially in regard to methods of taking the thrust of the screws. In the first example shown, the screws are laid in from the front, which necessitates an open slot; but a more workmanlike way is to take the thrust a little way inside the hole by means of a loose collar *A*, Fig. 10, slipped in after the screw has been inserted endwise, and secured with a couple of pins fitting half way in the chuck and half way in the collar. Or the screw collar is brought further in, resting against a shoulder, and the loose collar is laid in as at *B*, Fig. 10; this is an alternative to using the tail of the screw to receive the thrust in one direction. Instead of a plain collar, however, a threaded one may be used which can be tightened to make an exact working fit without backlash and which is locked with a lateral screw; this device permits of later adjustments to eliminate backlash due to wear,

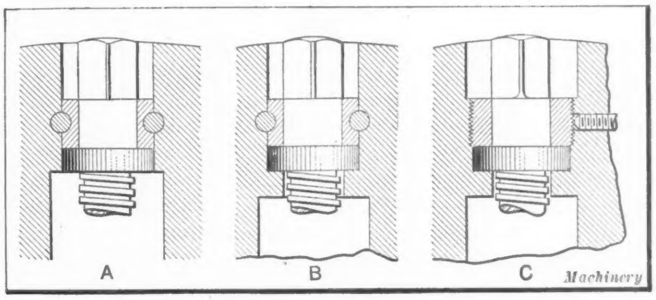

Fig. 10. Screws retained by Collars of Various Types

as shown at *C*, Fig. 10. It will be noticed that the essential difference between this class of chuck and the various types of modern chucks now on the market is the way in which the jaws are fitted into the body. The chucks thus far described take a bearing by the squared tail, but in the modern types the chuck bodies are grooved to receive the tongued bases of the jaws, resulting in a much better fit and greater resistance against lateral pressures. It is now the practice in making old-fashioned independent-jaw chucks to recess the jaws slightly in the body, which tends to keep them in line and to relieve the pressure from the screw stud end, as illustrated in Fig. 12. But this does not overcome the tendency to tip over; hence the necessity for the screwed tail and nut at the back.

Reversible jaws on the independent-jaw chucks of the class just illustrated are arranged upon a kind of stud, corresponding to the shank of an ordinary jaw, but with a circular portion upon which the jaw may be rotated. The driving screw is given a slight amount of play, as shown in Fig. 13, so that when the nut at the back is slackened the jaw and shank may be pulled out sufficiently to clear the tongue on the under side of the jaw, making it possible to reverse the jaw.

The design of independent-jaw chucks with tongued jaws, Fig. 14, is employed now to a far greater extent than the other class previously described. The screws are of large diameter, and the tendency of modern practice has been to increase thicknesses of metal in the body, width of jaws, and to use steel bodies, or cast-iron bodies reinforced with steel. Modern practice is rapidly tending also to continue the threaded portion of the screw at the outer end, Fig. 14, to the outside periphery of the chuck. This necessitates modifying the method of taking the end thrust of the screw, that is, transferring the location of the thrust bearing to a position about half way down the screw. A thrust pad or plug is generally inserted from the back and secured with a screw or screws set at its side, or centrally. The use of a thrust pad is advantageous from the point of view of durability, since it can be hardened

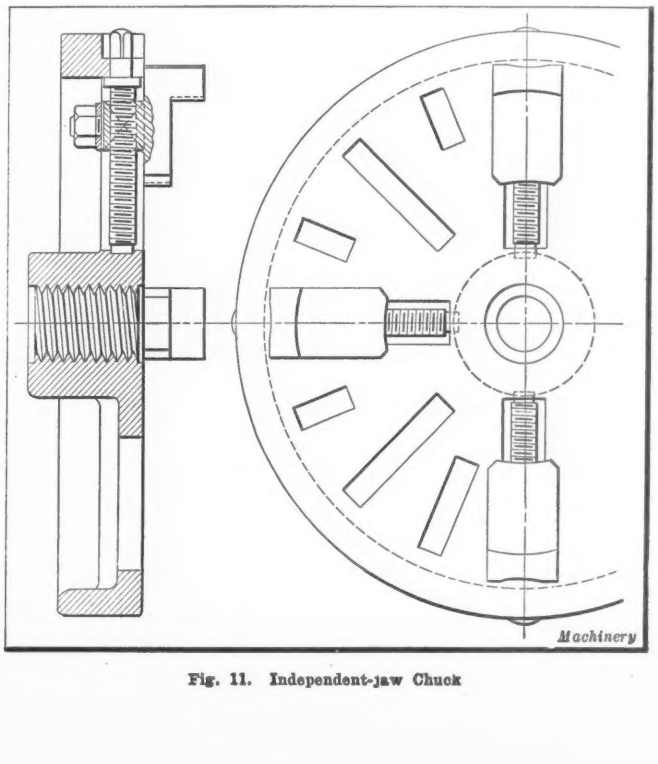

Fig. 11. Independent-jaw Chuck

and so form a medium that is greatly superior to any portion of the chuck itself for resisting wear. The Cushman thrust pads are split and expanded into their seatings with a taper-headed screw. The Horton chucks employ a tapered block *A*, Fig. 15. A peculiar arrangement is seen in the design of the Oneida National Chuck Co.; here, as shown at *B*, Fig. 15, a steel ring is laid in the mold and incorporated in the casting when pouring, thus forming a powerful reinforcement to resist the outward strain imposed when the work is gripped. Where the thrust shoulders of the screws come they lap over this ring, so that the thrust is received by it.

Holes and slots of through or T-slot type are variously made in independent-jaw chucks for the reception of bolts, the precise arrangement often depending on the size of the chuck.

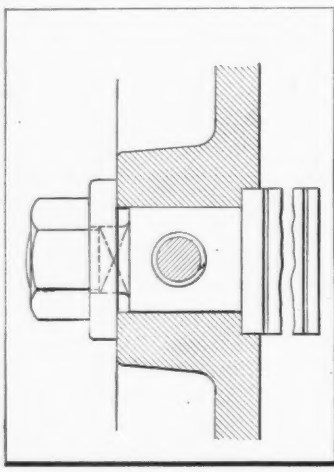
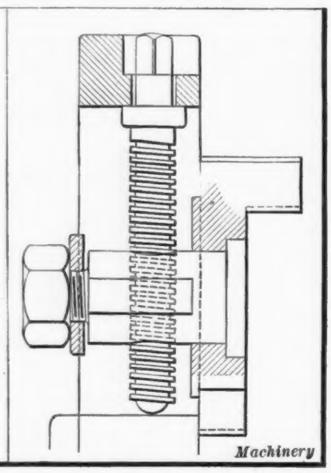

Fig. 12. Jaw recessed slightly into Plate

Fig. 13. Reversible Jaw swiveling on Stud

In the larger chucks for heavy lathes and for boring mills the number of T-slots is increased, and frequently the jaws do but a fraction of the work of holding, the major part being undertaken by bolts, clamps, and driver pins. A ring of teeth for driving a heavy plate is either bolted upon the back, or is cut solidly as in Fig. 16. Increased stability and wearing capacity of jaws is obtained by widening and deepening them, thus enlarging the wearing areas and affording better resistance against tipping. The Horton widened jaw with flanged base, Fig. 17, offers a radical departure from the ordinary grooved jaw, and is well adapted to severe service. The effect of the increased width of base on the size of the screw is that it can be greatly increased in diameter. The Union Mfg. Co. has a system of double ribs in its heavy type chucks, shown

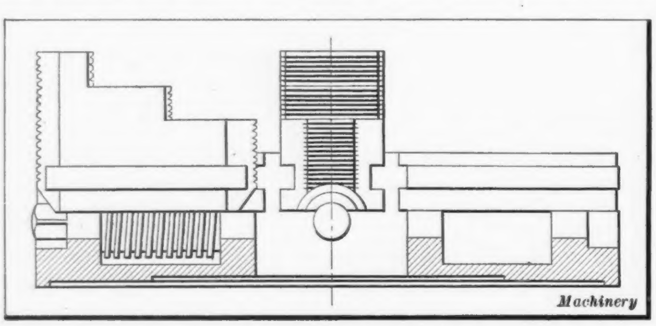

Fig. 14. Heavy Independent-jaw Chuck with Tongued Jaws

in Fig. 18, the jaws, of course, entering more deeply from the chuck face than usual.

Concentric or Universal Chuck

Although independent-jaw chucks have a series of circles struck upon the face for centering the various jaws approximately, this method lacks accuracy and speed when there are many of the same pieces to be chucked. The simultaneous operation of the jaws is highly essential for this class of work, and this is provided by the concentric or universal chucks. Two methods are in use for effecting the movement of the jaws in unison. One is to connect each screw with a bevel gear meshing with its pinion, and the other is to abolish the screws and move the jaws directly by a scroll plate engag-

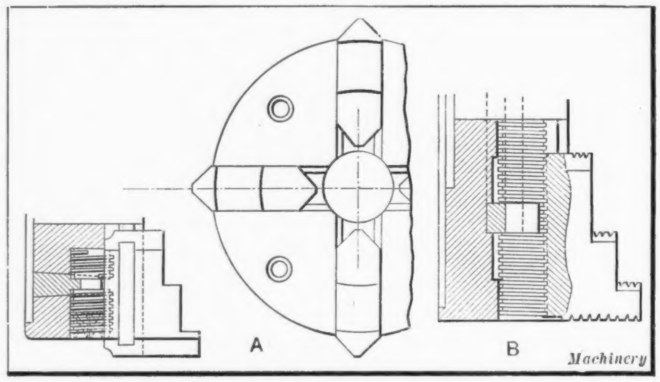

Fig. 15. A, Horton Chuck Jaw with Tapered Block; B, Oneida Chuck with Thrust Ring

ing with teeth on the back of the jaws. Rotation of the scroll plate is effected either by direct hand or lever pressure, or through the medium of gears. The objection to the screw method is the tendency to wear in the threads, which introduces backlash, rendering exact concentric action unlikely after a little use. The strain on the circular rack and the pinions is also very severe, and for this reason it is advisable to only lightly tighten one pinion to set the jaws upon the work, and then go round and set up each screw hard with its own square, pursuing the reverse method when loosening the work. Fig. 19 will serve to show the principle of the geared screw design of universal chuck, this being a type of car wheel chuck made by the E. Horton & Son Co.

What are termed lever scroll chucks are the weakest from the point of view of tightening; the scroll ring is rotated either by the grip of the fingers on a knurled rim, or by means of a tommy rod inserted in a hole in the rim. These

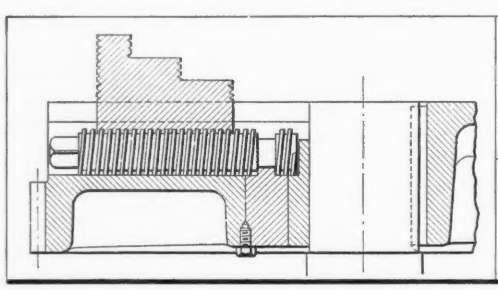
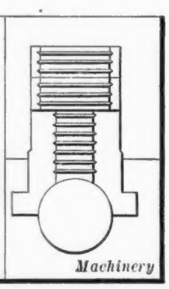

Fig. 16. Heavy Independent-jaw Chuck with Spur Gear Drive

Fig. 17. Jaw with Wide Base

chucks, Fig. 20, are used by amateurs and light lathe workers, and are very handy for work within their power because of the ease with which tightening and releasing is done. But there is a definite limit to the gripping power, and a gear drive to the scroll becomes essential. In most instances bevel gears are utilized. There is one exception—where worm-gears are employed—and another, the Westcott, where spur gears are fitted, both designs being intended to increase the power. The ends of a bevel pinion usually run in parallel bearings, but an exception may be observed in Fig. 21. Here it will be noticed that the outer bearing is of coned form so that the backward thrust of the pinion always makes the tapered bearing fit without shake. Another variation is met with in the Whiton practice; here the key is formed to act as a part bearing, Fig. 22. The latest pattern of Horton chuck offers a

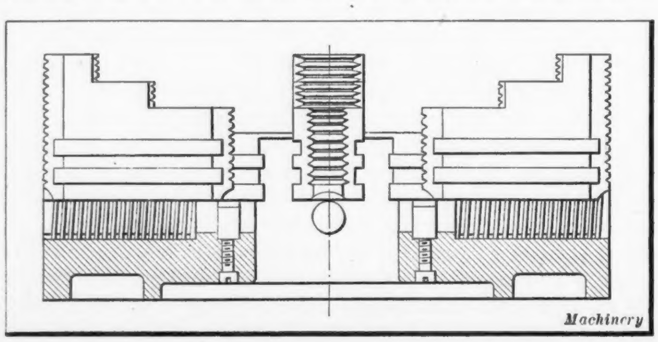

Fig. 18. Union Double Tongued Jaws

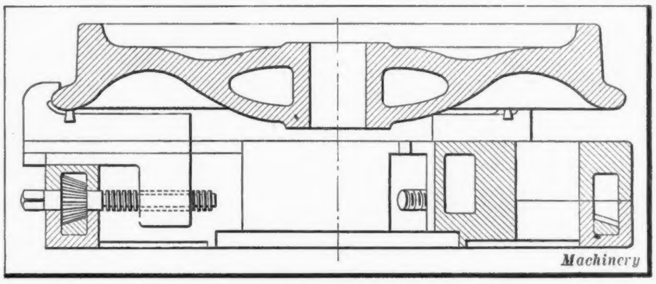

Fig. 19. Universal Car-wheel Chuck

modified arrangement of pinion bearing, seen in Fig. 23, the outer end of the pinion being nearly as large as the outer diameter of the teeth, so as to allow of a very large hole for the powerful wrench which is employed. A thrust ring is placed as shown to afford sufficient bearing for the backward pressure. It may be mentioned that the teeth used are of the Brown & Sharpe stub form, and this strong shape in conjunction with the fact that the pinion is of heat-treated steel, oil-hardened, makes for great durability.

Messrs. Alfred Herbert, Ltd., of Coventry (England) manufacture a concentric chuck *A*, Fig. 24, which differs radically from all others by the fact that a spiral is not used, but three eccentric grooves are formed in a ring. In these grooves three sliding blocks are confined, which, in turn, are attached to three T-slides. These T-slides have serrated faces which fit into numerous serrations on the jaws and are held in place by two screws. As the sliding blocks fit the short eccentric grooves exactly at all positions, they do not suffer from the

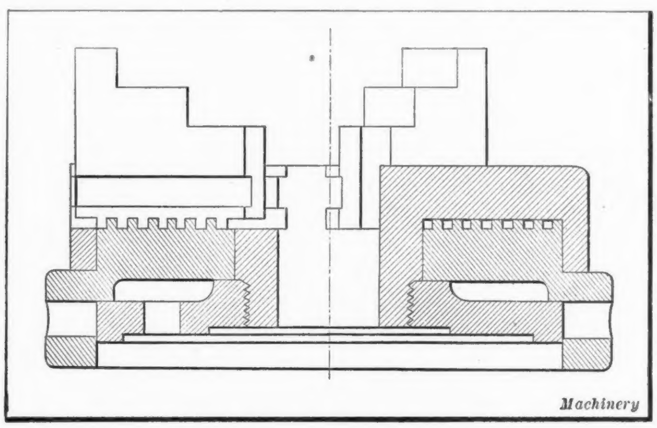

Fig. 20. Lever Scroll Chuck

disabilities incurred in trying to make a jaw of constant curvature match the varying radii of a spiral comprising many circles, as is the case in a scroll chuck. The jaws, which are reversible on the slides, may be adjusted to and from the center by slacking the two holding screws half a turn and resetting by matching the accurately cut serrations. With this device it is also possible to hold eccentric or irregular work as well as concentric work. The standard jaws furnished cover the range of all diameters of the chuck with two steps only. Heat-treated chrome-nickel alloy steel is employed for the pinions, which have eight teeth of the shape shown at *B*, Fig. 24, and the ring carrying the teeth and eccentric grooves is of heat-treated steel, ground in the hole. Three sector plates, doweled and screwed on, constitute the face of the chuck, and they carry the numbered circles by which the jaws are set concentrically. Although this design of chuck does not provide for running the jaws in or out any distance (as an ordinary scroll chuck does) it is claimed that modifications in diameters are more quickly and easily made by the slackening of the screws already mentioned than by tedious running in or out. The chuck is not intended to compete with light cheap kinds, of course, but is for the heaviest service, built in capacities from 12 to 25 inches.

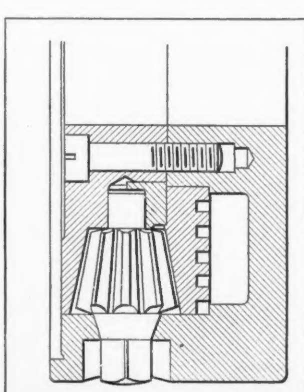

Fig. 21. Pinion with Tapered Journal

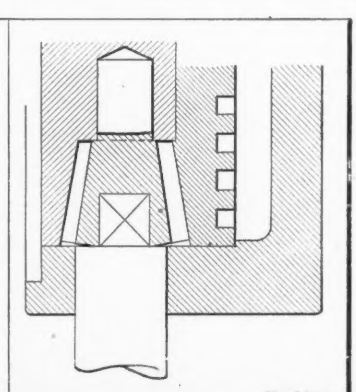

Fig. 22. Pinion Wrench turning in Chuck Hole

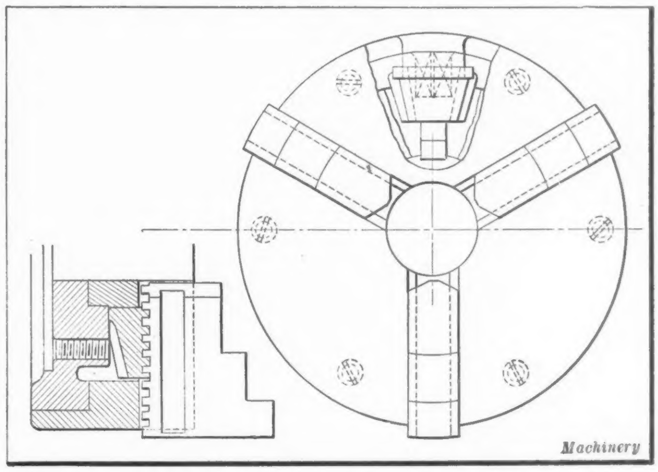

Fig. 23. Horton Universal Chuck with Large Wrench Socket in Pinions

Another distinct departure from ordinary design is the Taylor "spiral" chuck which, instead of having the scroll teeth cut upon a plane face, has them made in a hollow cone, Fig. 26, and of V-section. They present a backing to the teeth of the jaws directly in line with the pressure, and more than half the pressure is taken by solid metal. It is possible to use a much finer pitch of spiral than in the ordinary design, and the threads can be hardened and ground, both in ring and jaw. The jaws necessarily slide down inclined grooves, and this, incidentally, has the beneficial effect of partly masking them within the chuck cone so that there is less liability for them to catch in workmen's clothes or hands.

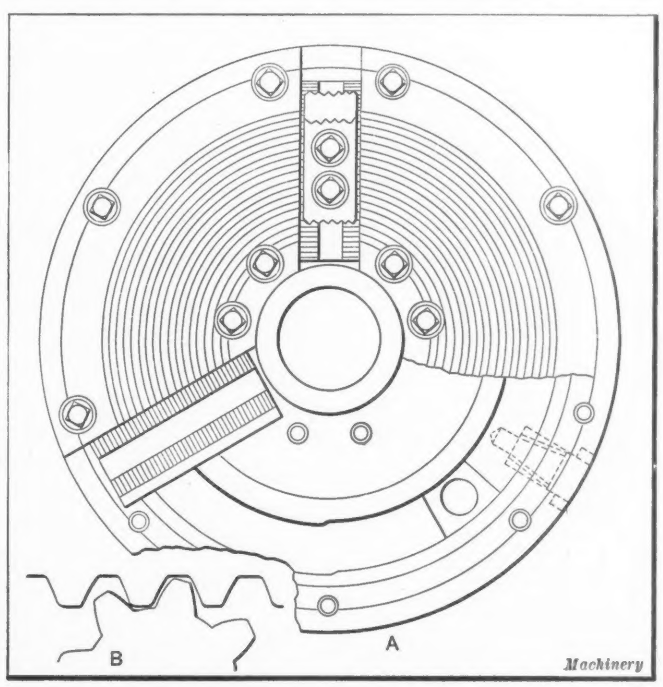

Fig. 24. Concentric Chuck with Cam Ring instead of Scroll

Chucks with two jaws only are not so frequently operated with a scroll as with a screw. When using the screw there is no need to have a complete round body, and the sides can be flat, constituting a box body, which saves weight and is

more convenient for holding certain classes of work. An independent-jaw box-body chuck has the jaws moved by separate screws, but a universal-jaw type has a single screw with right- and left-hand ends. The location of the screw determines whether the work may pass by the jaws into the chuck body or not. If the screw is set centrally *A*, Fig. 25, it obstructs the passage, but if at the side, *B*, there is nothing to prevent the work from extending into the body.

Combination Chucks

In a universal chuck of the scroll type the radial movement of the jaws is produced solely by the rotation of the scroll, and the labor, wear, and time incurred by this procedure in large chucks is highly objectionable. This has brought about the practice (in chucks for boring and turning mills) of mounting the jaws with interlocking serrations on the faces of separate slides which mesh with the scroll. This gives provision for rapid loosening of the jaws and their transition to or from the center, in the same manner as in the Herbert chuck previously illustrated.

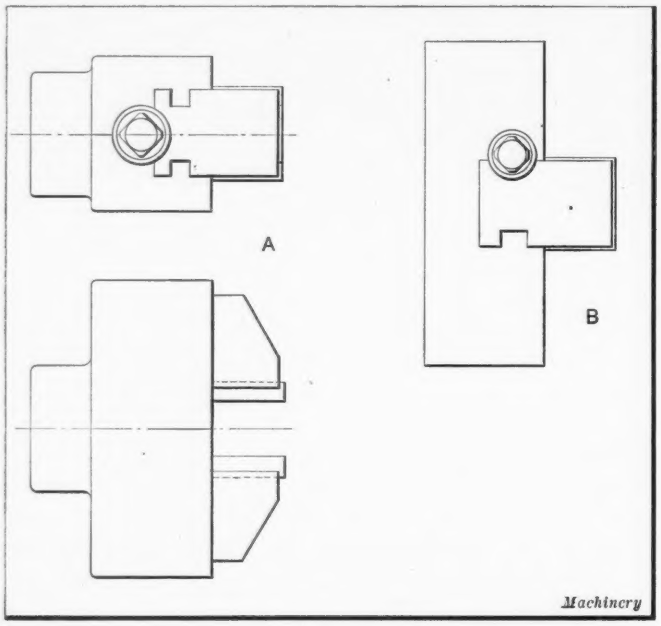

Fig. 25. Brass Finisher's Chuck

Having seen the principles of operation of both independent and universal chucks, we will now consider a type which affords a useful blending of the two kinds, the combination chuck. This, as its name implies, provides either independent or universal movements of the jaws as desired. Two devices are in common use for attaining this end, one being to employ geared screws and arrange the rack so that it may be dropped out of mesh, and each screw turned independently, and the other to use a scroll but give each jaw a separate movement by an independent screw. When the rack device is utilized it is generally lowered by removing a ring from the back of it, or by turning a ring with raised nibs which enter into recesses in the rack and allow the latter to drop sufficiently. In a Pratt & Whitney design, Fig. 27, the ring is grooved so that when partly revolved it lowers the rack out of engagement. The Westcott chucks have a ring provided with concave places underneath to fit over lugs standing up in the back of the chuck, and provision is made to partly rotate the ring and bring the straight back onto these lugs, thus raising the rack into gear with the pinions. Several chucks are designed on this general principle. The scroll and screw design also finds much favor, an example being seen in Fig. 28 (Horton), with very large screws. Another chuck, with screws having a central thrust collar and a worm-gear for turning the scroll, is shown in Fig. 29.

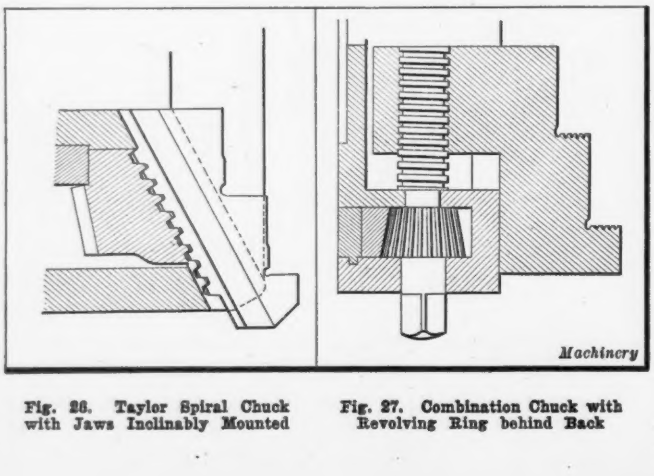

Fig. 26. Taylor Spiral Chuck with Jaws Inclinably Mounted

Fig. 27. Combination Chuck with Revolving Ring behind Back

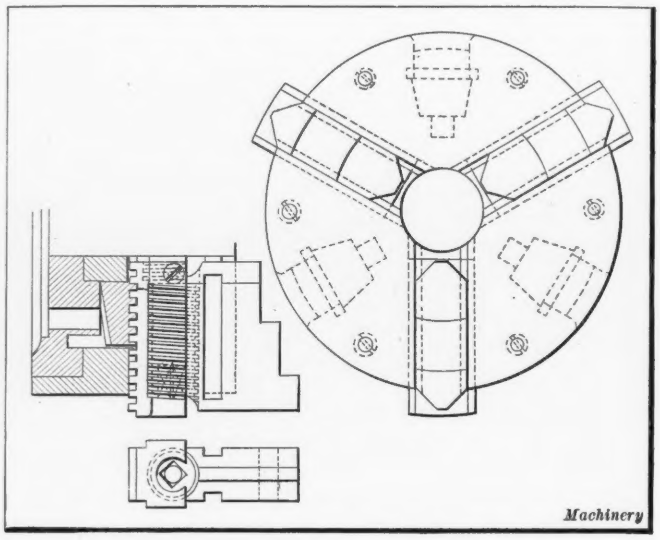

Fig. 28. Combination Scroll and Screw Chuck

The combination chuck is disparaged by some, but it nevertheless fills a useful sphere, particularly in cases where the expense of two separate chucks is objected to, or the trouble of changing one for another frequently arises. Some general runs of work require frequent changes from a universal to an independent chuck and *vice versa*. When dealing with eccentric work it is a great convenience to be able to adjust the jaws independently to suit the contour and then move them simultaneously in or out for repeated pieces. Some kinds of chucks, moreover, as those used on heavy lathes, turning or boring mills, are never changed, and the combination principle has to be embodied if the most useful style of chuck is desired.

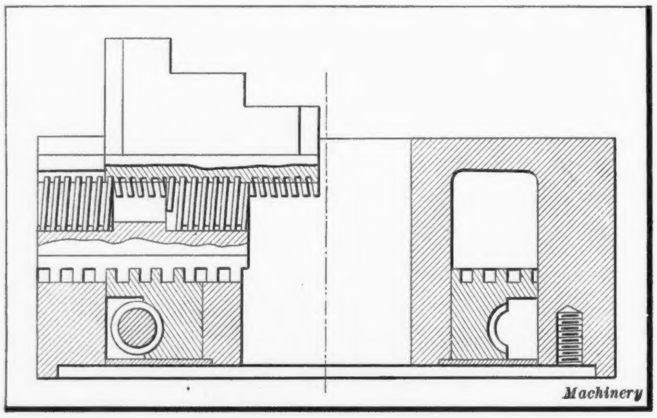

Fig. 29. Combination Chuck with Worm-gear

* * *

Aluminum alloys which are claimed to be extremely tough and strong and highly malleable when cast in chilled molds are composed of 91 per cent aluminum, 8 per cent zinc, 1 per cent cadmium, or 88 per cent aluminum, 10 per cent zinc and 2 per cent cadmium. When cast in sand molds, castings made from this alloy have a fine smooth surface and can be readily machined. When cast in chilled molds, the alloys can also be rolled into wires or flat bands. The method of manufacturing the alloy consists in adding zinc and cadmium with or without the addition of a suitable flux to the molten aluminum. The mass is maintained in a molten condition until the zinc and cadmium have been evenly absorbed and is then poured.

MACHINING OPERATIONS ON THE GEAR SHAPER

JIGS AND FIXTURES EMPLOYED FOR FINISHING THE SADDLE AND CABINET

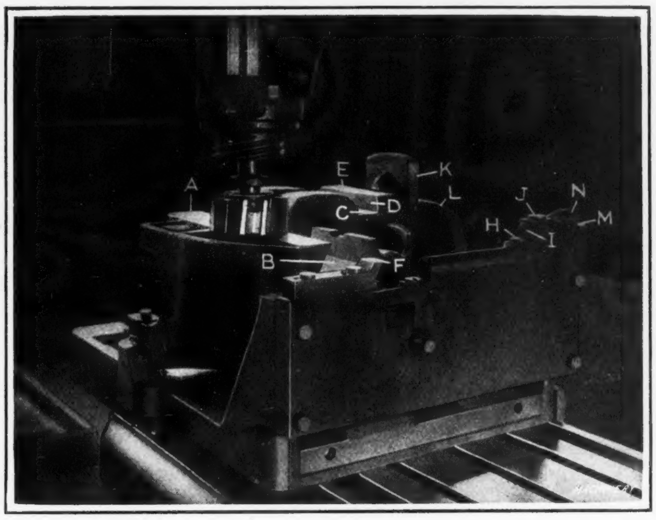

Fig. 1. Work set up on Milling Machine for roughing out Saddle Bearing

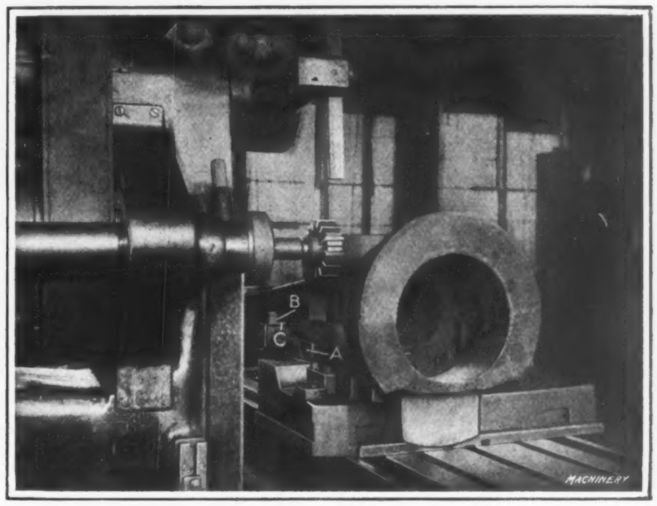

Fig. 2. Milling Bearings for Gib and Plate that hold Cutter-slide in Place

THE first step taken by a tool designer who is confronted with the problem of developing jigs and fixtures for machining some unusual piece is usually to refer back to the drawings of any tools which he may have designed for holding similar parts. There are men who have been fortunate enough to have had a wide experience in designing jigs and fixtures for machining a great variety of products, and such men will seldom find much difficulty in devising a satisfactory method of handling the most intricate work, but the experience of the average tool designer is likely to have been confined to some specific line, and consequently the development of tools for exceptionally difficult machining operations is purely a matter of ingenuity and likely to consume an unnecessary amount of time.

But the tool designer who is engaged in a given line of work always has the opportunity of gaining the equivalent of experience in handling other lines by reading descriptions of jigs and fixtures developed by designers engaged in such work; and he will frequently find it possible to apply ideas acquired in this way in the development of tools for use in the factory in which he is employed. Were it not for the possibility of applying ideas in this way, there would be little point in the publication of detailed descriptions of jigs and fixtures employed for specific machining operations.

It is the purpose of the present article to describe the milling, boring, planing, drilling and reaming operations performed on the saddles and cabinets of gear shapers built by the Fellows Gear Shaper Co., Springfield, Vt. In machining the saddles, it is necessary to make use of the milling machine, horizontal boring machine, horizontal drilling machine and planer, and the first part of the article will be given over to a description of the tools and methods of procedure employed in performing machining operations on each of these machine tools. The cabinets of the machines are first planed on their upper and lower surfaces, after which they are set up in a jig that is used in conjunction with two radial drill presses which drill and ream all of the holes; and a description of this work will be presented in the latter half of the article.

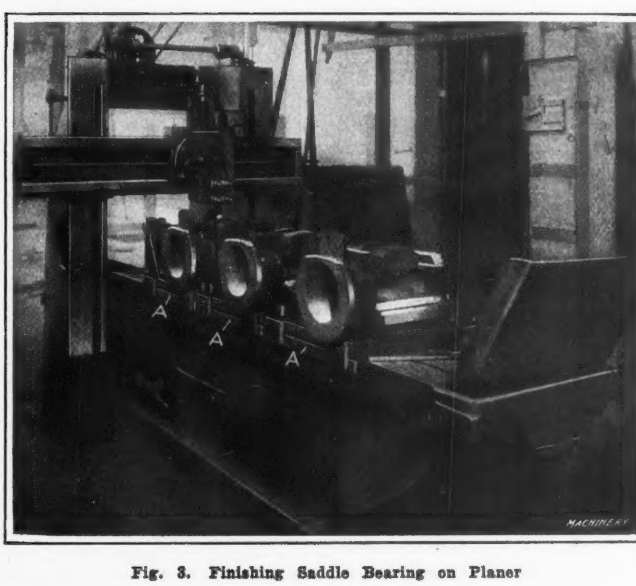

Fig. 3. Finishing Saddle Bearing on Planer

Milling Chucking Spots and Rough-milling Saddle Bearing

The fixtures used for performing the second and third operations on the saddle castings are provided with three hardened steel pads which locate the work from three chucking spots. These spots are provided by milling the faces of three bosses which are cast on the saddles for that purpose, and the first operation consists of performing this work. For this purpose the saddles are blocked up in approximately a horizontal position on the milling machine table, a No. 4 Cincinnati vertical milling machine being employed for the purpose.

The second operation consists in rough-milling the bearing by which the saddle is supported on the machine. As previously mentioned, there are three pads on the fixture in which the work is held, which locate the casting from spots that were milled by the preceding operation; and in addition, there are five hardened gage spots on the fixture, which are brought into contact with the cutter before each milling cut is taken, in order to provide for locating the table in the desired positions. The five surfaces to be milled are shown at *A*, *B*, *C*, *D*, and *E*, Fig. 1, and the hardened gage spots provided on the fixture for locating the milling machine table in the proper positions for taking a cut over each of these surfaces are shown at *F*, *G*, *H*, *I*, and *J*, respectively. The cutter shown in Fig. 1 is employed for milling surfaces *A* and *E*, after which a smaller cutter is substituted for reaching surfaces *B*, *C*, and *D*. The work is done on the same machine as was used for milling the chucking spots on the castings.

Planing the Saddle Bearing

The third operation consists in finish-planing the surfaces that were rough-milled during the previous operation, and for this purpose the work is held in the fixtures in which the roughing operation was performed on the milling machine; but in planing, three of the saddles are set up at a time on a G. A. Gray planer, the arrangement being clearly

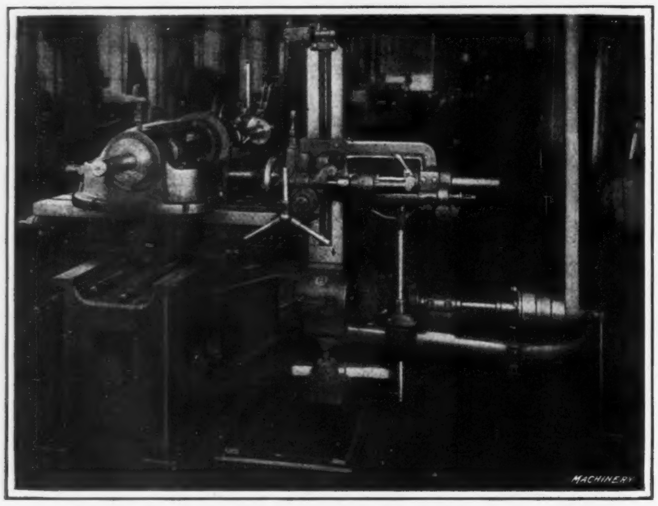

Fig. 4. Arrangement of Lucas Boring Machine and Barnes Drill for machining Holes in Saddle

shown in Fig. 3. A tapered gib is provided in the cross-rail bearing in the saddle to afford means of compensating for any wear that may develop in this member of the gear shaper, and it is the necessity of machining the bearing to receive the gib which led to the employment of three separate fixtures instead of constructing a single planer fixture for holding three saddles at a time. The use of the individual fixtures makes it possible to employ taper strips *A* between the fixture and the edge of the planer table, to locate the work at the proper angle for planing the gib bearing. In other respects the finishing of the five surfaces *A*, *B*, *C*, *D* and *E* of Fig. 1 by planing is essentially the same as that followed in the rough-milling operation, so that further description is unnecessary. In addition the surfaces *K* and *L* to which the worm-box is attached are finished while the work is set up on the planer, and the hardened gage spots *M* and *N* are planed on the fixture to provide for setting the tool to take the required depth of cut.

Milling Bearing Surfaces for Gib and Side Plate that Hold Cutter-slide in Saddle

The cutter-slide or ram runs in the cylindrical bearing in the saddle, which is open at one side as shown in Fig. 2; and the slide is held in its bearing by a flat plate and a taper gib at opposite sides of the opening. It will be recalled that the bearing by which the saddle is supported on the cross-rail of the machine has already been finished, and the fixture employed in performing the fourth operation holds the casting in exactly the same way that the finished part will be supported on the gear shaper. This method of holding the work will also be employed on all subsequent machining operations on the saddle. There are six surfaces to be milled, and the work is done on a No. 4 Cincinnati horizontal milling machine, the arrangement being shown in Fig. 2. The end of the cross-rail on the fixture, which supports the work, is shown at *A*; and two of six hardened gage spots that locate the cutter for the performance of successive milling operations are shown at *B* and *C*. Location of the work for milling the bearing for the taper gib is obtained by a strip placed between the fixture and the edge of the milling machine table, the arrangement being essentially the same as that explained in connection with the description of the planing operation.

Boring and Drilling Operations on the Saddle

The fifth operation consists in boring and reaming the holes for the cutter-slide, the index wheel, the driving shaft, and the lead-screw. Two of these holes are located at right angles to the other two, and to provide for machining all four holes at a single setting of the work, the equipment used consists of a No. 6 Lucas boring machine which has the head of a No. 2 W. F. & John Barnes horizontal drill press bolted to the side of its bed, the arrangement being clearly shown in Fig. 4. The fixture which holds the work is of the same design as the one employed for the preceding operation, *i. e.*, the casting is supported from the cross-rail bearing. It will be evident from the illustration that the bearing for the slide and the housing for the index wheel are machined by cutters carried on the spindle of the Lucas boring mill, while the holes for the lead-screw and driving shaft are drilled by the Barnes horizontal drilling machine.

In boring the holes for the cutter-slide and index wheel, three cuts are taken over the work. The roughing cut leaves 1/16 inch of surplus metal and the intermediate cut leaves 0.010 inch to be removed during the finishing operation. In drilling the two holes for the lead-screw and driving shaft, two operations are required. A roughing cut is taken with a core drill which leaves 1/32 inch of surplus metal that is removed during the finish-boring operation.

Facing Off Index Wheel Flange and Turning Edge of Flange

The final operations consist of facing off the flange on which the index wheel rests, turning the edge of this flange, and cutting the scraping groove. For performing these operations, the work is set up on a Lucas horizontal boring mill, which is equipped with a star head.

Machining Operations on Cabinets of the Gear Shaper

The planing of the flat surfaces on the cabinet of the Fellows gear shaper are commonplace operations which require no description. There are three parts that comprise the work to be machined. They are the cabinet, the swinging apron, and the apron lever. The holes to be machined are the hole which carries the work-spindle quill, two holes which support pivots for the swinging apron, two holes which carry the plungers that operate the apron lever, and the hole which carries the lever stop. The plunger holes and the lever stop hole are cored out at the time the casting is made; and in addition to the drilling and boring operations referred to, it is required to face the top and bottom of the hole in which the work-spindle quill is carried.

The cabinet *A*, the swinging apron *B*, and the apron lever *C*, are assembled as shown in Fig. 5; and suitable means are employed for holding these three component parts in the required positions relative to each other. The machining is done on two radial drill presses, which are set up at right angles, as shown in Fig. 7, with the jig carried on the bed of one of the machines. The advantage of this form of equip-

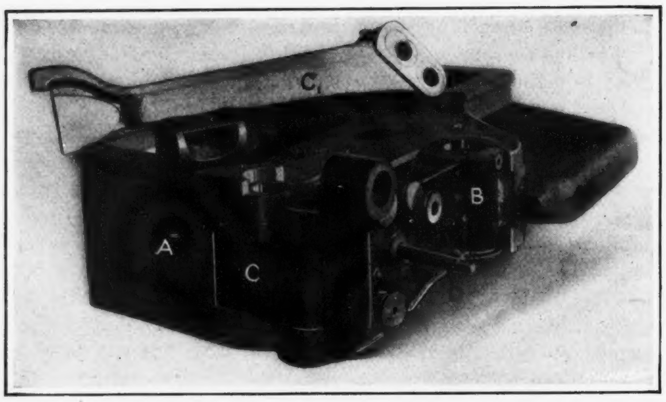

Fig. 5. Parts of Fellows Gear Shaper Cabinet assembled ready for Drilling Operations

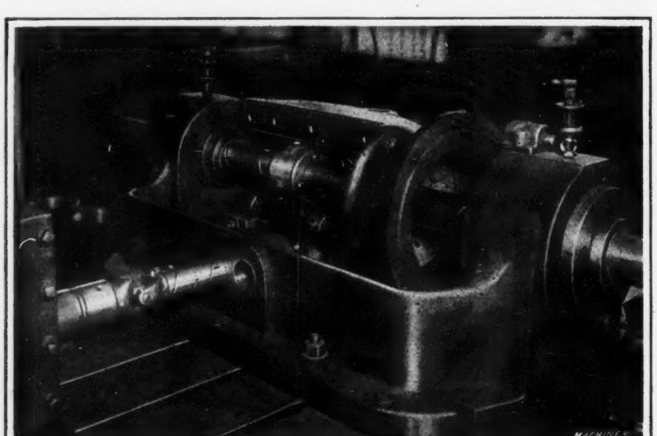

Fig 6. Close View of Work and Tools on Machines shown in Fig. 4

ment over a special boring machine is that the two radial drills are always available for standard classes of work, and they do not need to be changed in any way when it is desired to employ them for general drilling.

Construction of the Drill Jig

A close view of the drill jig with one of the castings in place is shown in Fig. 8. In locating the work in the jig, the casting is pushed back so that bolt *D*, Fig. 5, extends through a hole at the back of the jig; and the nut is screwed up on this bolt so that the finished faces on the apron *B*, Fig. 5, are drawn back against locating pads in the jig. Sidewise location of the work is secured by means of plunger *A*, Fig. 8, the work being moved the required amount to bring the index mark on this plunger into coincidence with a mark on the plunger housing before the bolt *D*, Fig. 5, is tightened to secure the casting in place in the jig.

After the work has been set up in the jig, the proper tools are used successively for drilling, boring and reaming the holes. A collection of the tools employed for this purpose is shown on the bases of the drilling machines in Fig. 7. Referring to the close view shown in Fig. 8, it will be evident that bushings are provided in the jig at *B*, *C* and *D* for locating the hole for the spindle quill and for the two holes which carry the pivots for the swinging apron. Hardened slip bushings fit into holes in the jig for grinding the different tools. The hole for the spindle quill is roughed out by means of a fly cutter, after which an intermediate cut is taken with the same type of tool. The bosses at the top and bottom of this hole are next faced off by tools carried in the fly cutter bar; and the hole is then reamed with a Pratt & Whitney inserted-tooth reamer. The holes for the pivots which carry the swinging apron are roughed out with a Morse shell drill and finished with a Kelly reamer.

For locating the hole which carries the lever stop, there is a bushing on the jig, which is carried by the swinging bracket *E*. After the lever stop hole has been drilled, this hole is used as a point of reference in locating the two holes for the plungers which operate the apron lever. The bushings through which these holes are drilled are carried by brackets which

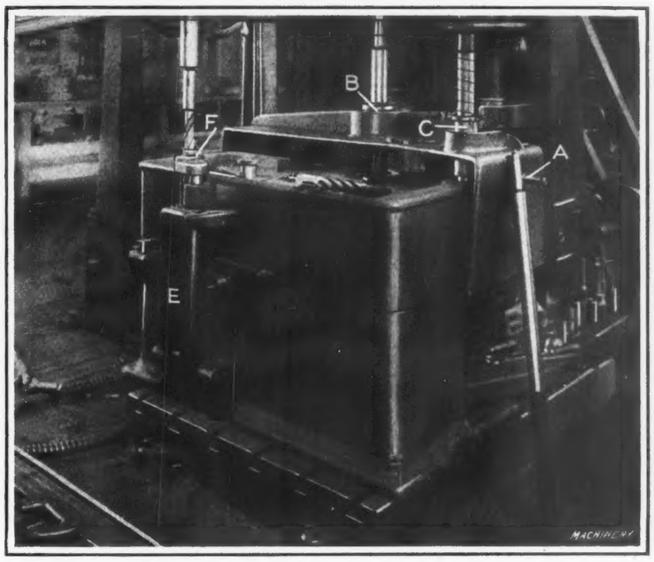

Fig. 8. Close View of Drill Jig used on Machines shown in Fig. 7

have stems that fit into the hole drilled for the lever stop; the distance between the holes is naturally determined by the length of the bracket, while the angular position of the bracket and bushing carried by it is determined by a spline on the stem that enters a keyway in the jig. These three holes are cored out in the casting; and in each case the roughing cut is taken with a twist drill, after which a Kelly reamer is employed for the finishing operation. The use of one of these bushings is shown at *F* in Fig. 8. In addition to the six main holes in the work, which have been referred to, there are a number of other small holes to be drilled; and it is interesting to note that all of these holes can be machined without requiring a second setting of the work. As regards both accuracy and rate of production, the results obtained from this method of machining are highly satisfactory.

E. K. H.

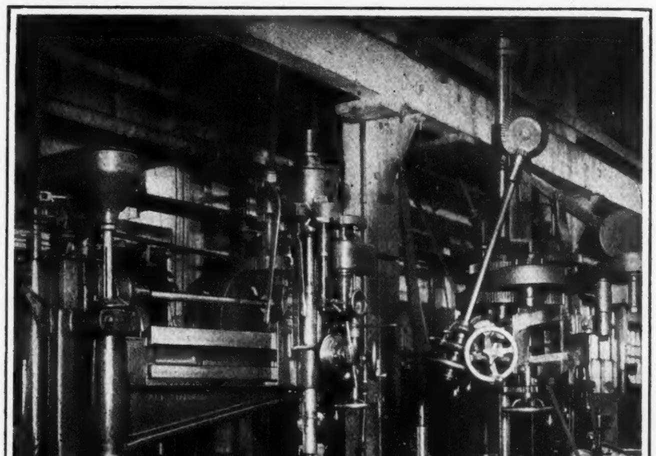

Fig. 7. Arrangement of Two Radial Drills for Operation on Gear Shaper Cabinets

* * *

STRENGTH OF DROP-FORGINGS

Several years ago we published in MACHINERY a paper read before the Franklin Institute, relating to the heat-treatment of alloy steels. In this paper the statement was made that drop-forging was very injurious to steel. We are informed by J. H. Williams & Co., Brooklyn, that this statement is erroneous, and that instead of the strength of drop-forged steels being less than that of steels not so treated, drop-forgings show a material increase of strength. With the ordinary run of mild steels from which the majority of drop-forgings are made, and which have, in the bar, a strength of from about 55,000 to 58,000 pounds per square inch, drop-forging will increase the strength to 62,000 pounds per square inch without any other treatment. With the higher carbon steels, having a tensile strength of about 80,000 pounds per square inch, there is no difficulty in increasing the tensile strength by means of drop-forging to 95,000 pounds per square inch. Where different results have been obtained it is no doubt due to the fact that drop-forging has been done under improper conditions. This, however, is no indictment of the drop-forging process, because any process conducted under poorly adapted conditions is likely to spoil the material being handled. When drop-forging is done by experienced men provided with the proper facilities, and working under suitable conditions, the process improves the strength of the steel.

* * *

The British Parliament has passed an act suspending for the duration of the war and until six months thereafter the operation of Section 27 known as the working section of the British patent act. During this period of suspension, no attack on British patents on the ground of non-working can be brought until six months after the close of the war and the period of suspension in Section 27 will not be reckoned against a patentee who has not worked his patent in Great Britain. The Act applies both to existing patents and to future patents which may be issued during the period of the war.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

MARCH, 1916

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MANUFACTURING TO GOVERNMENT SPECIFICATIONS

The manufacture of shrapnel, high-explosive shells, rifles, bayonets, cartridges and other munitions of war on contracts, undoubtedly will result in some American concerns acquiring wholesome experience in the meaning of government specifications. We Americans are impatient of restriction and our manufacturers are no exceptions to the rule. When building machinery or manufacturing a product, they sometimes change dimensions or modify forms to suit their own peculiar ideas, and the result may be a product highly satisfactory to them but one that does not conform to the designer's original plan. The making of shell fuses and other material of that nature was practically an unknown art to most American manufacturers eighteen months ago, and they had a very limited conception of the technicalities of the business, so that when some of them undertook to fill contracts for foreign governments they got into trouble.

Specifications for foreign military supplies are rigidly drawn, and inspectors have a disagreeable way of holding closely to them; in fact their orders leave them very little discretion. Slight variations, which to the American manufacturers may appear unimportant or even seem to actually improve the product, are usually rejected. In some cases, it may appear that the requirements are unnecessary. A thousandth inch more or less on a part "fitting the atmosphere," would seem to make no difference whatever in the functioning or integrity of the piece, but the inspector holds that it must conform exactly or be rejected.

The manufacturer who undertakes to fill orders for war munitions must organize his plant on rigid lines, holding every man to the exact performance of his work. Variations in measurements must not be allowed even if the work produced is interchangeable, for interchangeability alone is not sufficient. Not only must the parts be interchangeable but they must exactly conform in shape to those prescribed. The material must conform to physical specifications; not only must the weight of the bare metal agree with the specifications, but the amount of protective coating, whether paint, lacquer or other material, must be just the prescribed number of drams or ounces.

New and unsuspected problems in machine shop practice have been forced on some who expected to become rich quickly. For instance, the firing hole of a certain fuse is drilled with a No. 69 drill. The hole is 5/8 inch deep in steel; great difficulty has been experienced in finding drilling machines and drills that would stand up to the work. The reason was that the ordinary drilling machine could not be operated at the high rate required to give a No. 69 drill the proper cutting speed. The rotating parts are not in perfect dynamic balance, and the resulting spindle vibrations break the drills.

The contractors, confronted with this and similar problems, have criticised the design of the shell parts, saying, for example, that the wall thickness is too great or the diameter of the firing hole is needlessly small. The probability is that neither the wall thickness is too great nor the diameter of the hole too small. The dimensions have been carefully worked out by ordnance experts, and have been confirmed by hundreds of tests conducted at great cost. The factors of time, velocity, inertia, impact and explosive action are all interrelated, and slight variations might utterly upset the ordnance experts' calculations.

Although we excel as manufacturers in certain lines, much can be learned from this war business that should be so applied as to improve the products. The solution of problems continues with the production of war material like those of automobile manufacture; it means a step forward in the development of the machine tool industry, and our manufacturers will apply the knowledge so acquired to improve their methods and product. In the competition for the world's markets, we must learn to be particular about the apparent non-essentials and remember that there may be very good reasons for seemingly absurd specifications. Moreover, it is the customer's privilege to demand what he wants.

* * *

OUR CONSULAR SERVICE

The United States government maintains a consular service in foreign lands at heavy expense, and from it gains inadequate service compared with that rendered to their respective governments by the consular representatives of the great European powers. The trouble with our consular service is that it has been regarded as part of the legitimate patronage of the political party in power. Consequently many consuls have been appointed who had little or no knowledge of the business of representing their government abroad. They were unfitted by nature, temperament and experience for the exacting and arduous duties of the service.

Many of the items published in the daily *Consular Reports* are puerile, inaccurate and misleading. The consular service could be a great aid in developing American trade abroad if it were composed of men trained for such service, appointed without regard to politics, and assured that they would be retained in the service as long as they attended to business satisfactorily.

An example of the inaccurate reports is the item that appeared in the December 6 number, stating that the United Kingdom would prohibit, after December 21, the importation of all machine tools and parts thereof except small tools. Mention was made of a board of trade license, but the natural inference drawn was that machine tools would be practically barred from Great Britain after the date mentioned. The fact was that the importation of machine tools was simply restricted to established concerns, and that the profits of the business were limited.

The machine tool business is only one of many whose prosperity may be promoted or hindered by the consular service. It should be placed on a plane above the influence of patronage and party politics. Trained men of experience and good judgment are needed to represent the United States abroad as perhaps never before, to promote the vast foreign trade that will surely be ours if wisely fostered.

* * *

Statistics show that in the past twenty-five years, 113,570 persons were killed and 123,611 persons were injured while walking on railway tracks and jumping on cars in the United States. Practically all of these accidents could have been avoided if the public had been excluded from the tracks.

TAKING ONES OWN MEDICINE

BY A. PURCHASER

It is universally acknowledged that the cobbler's children are proverbially out at the heel. When, however, the cobbler has risen to the height of a leading manufacturer one naturally expects him to discard this slovenly policy, and to adopt one of progressiveness in the use of his own product in manufacturing that product. In other words, we expect him to take his own medicine. Does he? From the experience of a number of years spent in purchasing activities for a large factory I am convinced that in many instances he does not. A few actual occurrences that remain in my memory may serve to illustrate the point. One of my early assignments was to visit a factory building grinding machinery, to judge if the shop equipment would warrant placing an order with the company for a number of special grinders. In his effort to convince me of the high quality of their work, the superintendent conducted me through their shops, pointing out here and there the refinements of their processes.

"As you will note," he remarked, stopping before a fine automatic shaft grinder, "all of our shafts, spindles, etc. are ground to exceedingly fine limits."

"Very good," I replied, "but why do you use a Gash & Snaggum grinder instead of your own?"

Stammering explanations followed, how they happened to have the machine before they built grinders, how it was a very good machine and they were too busy to replace it, etc., etc. We bought our grinders of Gash & Snaggum.

As our plant increased in size and the coal handling problem became more important, I was delegated to look into the matter of handling it in a manner that would be cheaper than by the use of manual labor as we were then doing. One company sent us such glowing literature regarding its grab-bucket system for the purpose, that we decided to give its proposition consideration. By appointment, I met a salesman in the city and with him traveled to the suburban town in which the factory was located. All the way out he entertained me with figures, illustrations and a fine line of talk which, by the end of our half-hour's run, had nearly convinced me that the one and only way in which coal could be handled efficiently in any factory was by the use of the Hoistem Co.'s grab bucket.

As we approached the factory I noticed several coal cars on the siding of the plant and was much pleased at the thought that I should have an opportunity to see one of these buckets in actual operation. When we drew nearer, however, I was surprised to find that each car had a crew of laborers who were industriously shoveling the contents by hand into the factory yard, whence it was transported in wheelbarrows to the engine room. I didn't have to say anything to that salesman. He explained, as best he could, how the great volume of orders had so taxed the factory's capacity that they had never found time to build themselves any coal handling apparatus, but he knew as well as I did that the bluff was worthless. I spent a very pleasant morning with him and could appreciate the difficulty confronting him in not having the proper backing of his company—but we bought another kind of coaling equipment for our factory.

The same thing occurred when we decided to take out our long lines of shafting and replace them with individual motor drives in our machine shop. I called on three motor builders, and in each case found plenty of enthusiasm until I requested an opportunity to visit their shops. Then the enthusiasm suddenly died out and, very reluctantly, I was shown through a belt-driven factory. At best, in a few cases, the tools were grouped and the groups motor-driven, and in not every case was one of their own motors employed for driving the group. Naturally my reports to the management regarding individual drives were somewhat lukewarm. It all looked fine on paper, but I wanted to see the actual operation before becoming convinced that the possibilities in any degree approximated the claims.

Finally I visited a fourth factory whose owners had furnished us with the usual collection of impressive literature. As soon as I started to talk with the salesman, in whose charge I was placed, I sensed a difference. His claims were made with the conviction of one who is able to back up all his statements. In the matter of looking over the factory he anticipated me.

"But, Mr. P—, there is no use of our talking this thing over a batch of blueprints and photographs. Come right out into the machine shop and we can discuss each kind of drive as we go along, with the working illustrations before us."

There were no explanations nor apologies here. Into the shop we went. There was no lineshafting to be seen. Each machine was equipped with its individual motor and they were all of this company's make. As we came to each machine my conductor explained the different types of applications that they had worked out; he told me how we could arrange with the tool builders for the equipment of new tools with this particular make of motor, and showed how old belt-driven tools could be most readily altered to employ motor drive. He also explained how his company was ready to supply us with detailed drawings of the auxiliary brackets and gearing needed to secure the best results from the application, and even offered the use of their bracket patterns in cases where we planned to equip tools that were the same as those they had altered.

When the question of results arose, he showed me the different types of tools in actual operation under the improved conditions and explained the savings they were making over the old methods. When we stood beside a lathe and saw the lathe hand, who was facing a casting, "notch up" his controller six times as the cut ran in toward the center, it was very clear that he was getting all the cutting speed that the tool would stand. I knew well that if the same work was being done with a belt-driven tool, the belt would not have been shifted once through the entire cut. This one demonstration was enough to satisfy me that there was something in this salesman's claims; and by the time the work of each tool in succession had been thus graphically analyzed, I was fully convinced. Furthermore, the salesman seemed to take it for granted that I would be. Possibly some of the other makers had shown me just as good motors—motors that were capable of just as efficient application and of making just as great a saving. But they had failed to produce the demonstration necessary to carry conviction. It will not be difficult for the reader to guess which one of the motor builders, visited in my investigation, secured our order for motor equipment.

* * *

In a recent consular report, a letter from A. H. Baldwin, commercial attaché of the Bureau of Foreign and Domestic Commerce of London to the London *Telegraph* was reproduced. Mr. Baldwin pointed out the great difficulties confronting the British Ministry of Munitions in providing an adequate supply of machine tools, especially for the new national factories. All the machine tool factories of the country have been placed under government control, but their output is not nearly sufficient to meet the huge demand. The government realizes the need for getting into its hands every available machine tool, and one of the results is the recent proclamation prohibiting the importation of machine tools into Great Britain. Mr. Baldwin says that it may be the intention of the government to prevent firms from securing new machine tools necessary for carrying on their business so that these tools can be used for national purposes instead, and it is further thought that the government will acquire machine tools from those few existing factories that have not every such tool engaged on munition work, although they might be needed for maintaining ordinary trade connections. He says that of course the nation's interests may compel such sacrifices, but they will entail immense industrial loss which could perhaps be avoided if the government would set up its own machine tool factories. This could be done by setting apart one or more of the new national arms factories simply for the purpose of supplying machine tools to the other national factories. Already certain controlled works have concentrated on the production of the jigs and gages needed in shell production. It would therefore be only a further step in the same direction to establish a national machine tool factory.

PLANING HELICAL SURFACES

BY EDWARD W. MILLER*

The cutter path of the Fellows helical gear shaper is controlled by a helical guide corresponding in lead to that of the cutter. A taper hole in the guide insures a good fit on the cutter-spindle, to which it is rigidly clamped so that the two may act as one piece. The guide has a bearing in a sleeve fitted and held to the upper index wheel. The helical surfaces of the guide bear against similar surfaces of a shoe fast in the

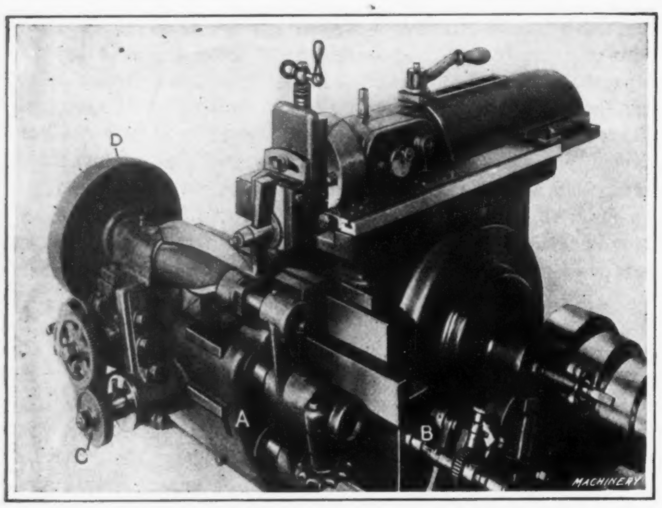


Fig. 1. Shaper Attachment for planing Helical Surfaces

sleeve and a gib which may be moved endwise in the sleeve. This rather unique gib affords an easy and correct adjustment for wear. As the cutter-spindle travels up and down, the guide bearing against the shoe and gib imparts the necessary twisting movement to pass the cutter through the work in the proper path. The machining of this helical surface presented a problem which was solved by a planing fixture adapted to a crank shaper.

Slide *A*, Fig. 1, is fitted to the shaper cross-rail, being operated by a special shaft *B*. This shaft, threaded far enough to allow ample slide travel, engages a square threaded adjustable nut. Extending farther as a plain shaft, it passes through a bevel gear integral with a sleeve which bears in the slide. A long spline in the shaft fits a key in the gear, causing it to rotate as the slide is fed along. Through a mating bevel gear,

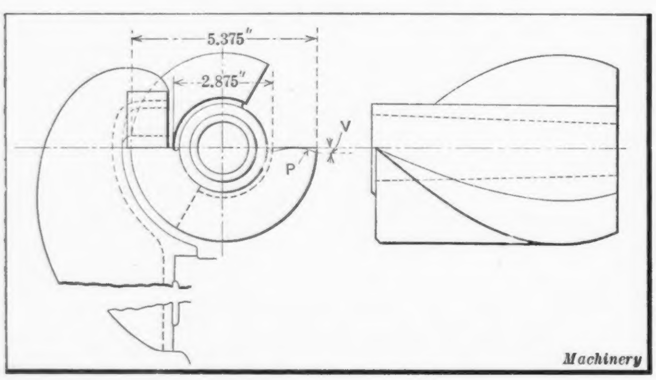


Fig. 2. End and Side Elevation of a Guide for machining Helical Surfaces

motion is imparted to shaft *C* and then through the change-gears and worm to a self-locking worm-wheel *D*.

The worm-wheel is keyed to the work-spindle and causes its rotation. It is thus possible to plane a guide of any desired lead by using the proper change-gears. It will be noticed that the outer end of the work-spindle is controlled by a support. The guide is clamped with the square nut and positively driven by a pin in the spindle flange.

All the elements of a true helix are straight radial lines. Investigation demonstrates that a tool operating at right angles to the axis of the work will not produce a theoretically correct guide unless reduced to a point. Proof of the above statement may be demanded, and as the study and solution of the problem is interesting, reference may be made to Fig. 2. Here is shown the end and side elevation of a guide. The helix advance in one turn is 20 inches. A development of this helix presents a right triangle (Fig. 3) with the long leg 20 inches, corresponding to the lead of the guide. The lengths 16.885 and 9.032 are obtained by multiplying 5.375 and 2.875 by 3.1416. Solving triangles *OAB* and *OAD*, we obtain 24 degrees 18 minutes and 40 degrees 10 minutes. It is thus evident that the helix angle varies according to the radial distance from the center.

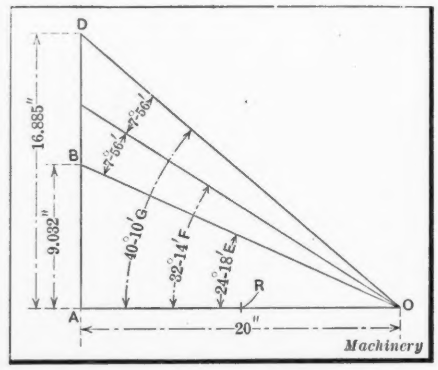


Fig. 3. Graphical Illustration of Helix Angles

In Fig. 4 let X–X represent the axis of the helical guide. Through any point *I* draw line *J*, making an angle equal to *F*, Fig. 3, with X–X. Draw *IK* perpendicular to *J*, and at any point *L* describe a circle passing through *I*. Draw *M* and *N*

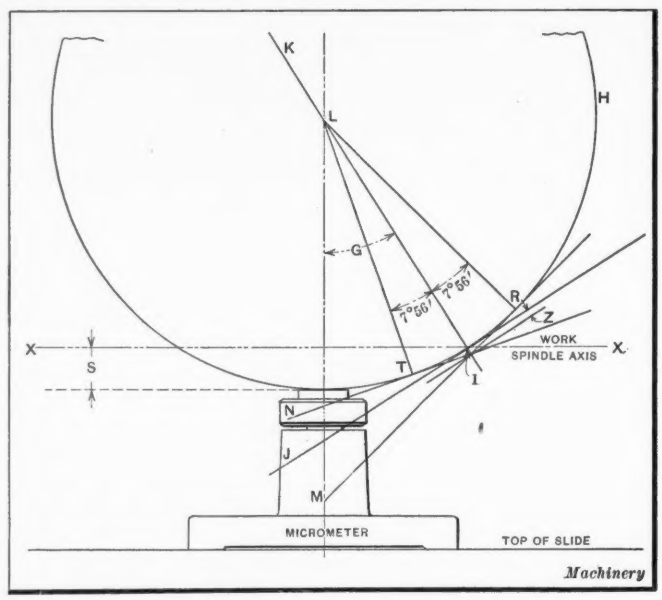


Fig. 4. Illustrating Method of determining Error

tangent to *H* at angles corresponding to *G* and *E*, Fig. 3. Let circle *H* represent a reciprocating tool traveling at right angles to the axis X–X. Angles *G* and *E*, Fig. 3, correspond to the helix angle developed by diameters 5.375 and 2.875, Fig. 2, and it becomes evident from the difference *Z* that the finishing tool does not produce straight radial lines. Only at point *I*, which marks the intersection of the guide axis with the helical angle 32 degrees 14 minutes, does the tool finish properly.

Evidently a tool consisting of a point only would produce correct results, but when of considerable diameter, as *H*,

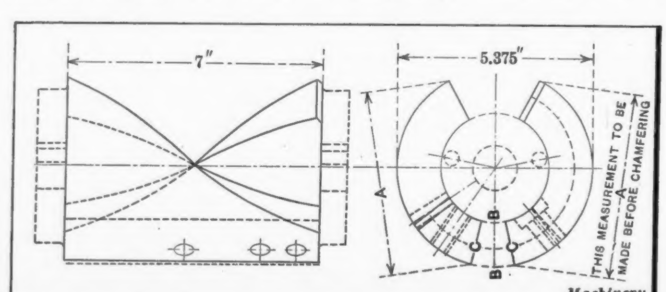


Fig. 5. Helix Shoe and Gib

* Address: Fellows Gear Shaper Co., Springfield, Vt.

there is contact at points R and T with lines M and N. The result is a curved surface P, Fig. 2, instead of a straight radial line. The height V of this curve is identical with distance Z, Fig. 4. The shorter the lead the greater is this error, inasmuch as shortening increases the difference in angles G and E, Fig. 3. This last statement is true when dealing with the problem at hand, since twenty inches is the shortest lead used. It is of passing interest to note that at point R, Fig. 3, the increase ceases and the angular difference decreases as point A is approached.

The guides are roughed with a round nosed tool of about 3/16 inch radius. The finishing is done with a piece of 1/8 drill rod gripped in a holder. Then with LR, Fig. 4, equal to 0.0625, error Z (or V as shown in Fig. 2) is obtained as follows:

$$\frac{0.0625}{\cos 7 \text{ deg. } 56 \text{ min.}} = 0.0641$$

$$0.0641 - 0.0625 = 0.0016 = Z$$

This 0.0016 is easily removed with a scraper.

The exact position of the cutting tool is of course important, and settings are determined from angle F, Fig. 3, as this is the intermediate angle position on the helical surface. The tool is located with a special micrometer, as shown in Fig. 4. When the top surface of the micrometer anvil coincides with the work-spindle axis, the reading is zero. When setting the tool, the screw is turned a distance equal to S.

$$S = 0.0625 - (\cos G \times 0.0625)$$

The planing process has proved a rapid and satisfactory means of production . The practical impossibility of machining these helical guides with a mill or grinding wheel is apparent when one considers the necessity of keeping the tool diameter to 1/8 inch.

The gage shown in Fig. 2 is useful in keeping the two helical surfaces opposite. Fig. 5 shows the helical shoe and gib. They are machined as one piece, the metal indicated by dotted lines being removed when the different operations have been performed. The gib and shoe are parted on line BB. Surfaces C are then machined to dimension A. Dimension A varies with the lead, and the necessary shop instructions are furnished in a table which accompanies each guide order.

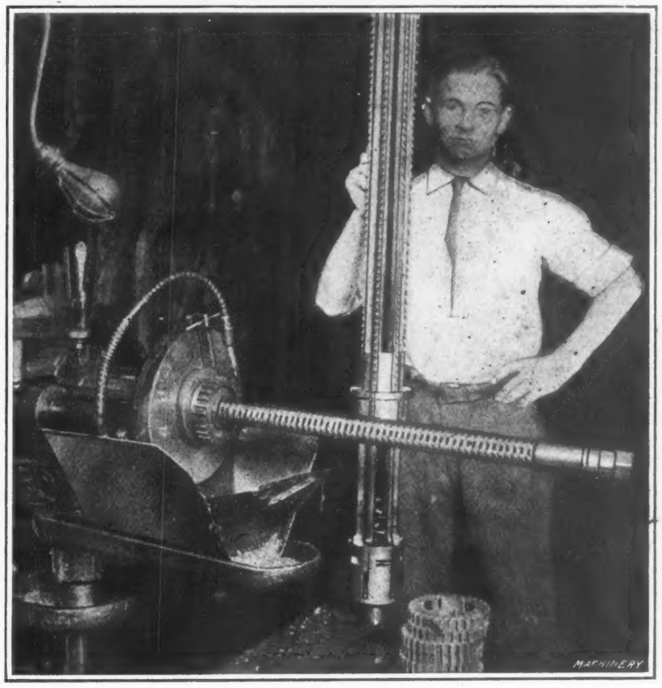
* * *

BROACHING TOOLS FOR MULTIPLE KEYWAYS

In one of the largest plants in the country devoted to the manufacture of automobile gears—that of the Brown-Lipe Gear Co. of Syracuse, N. Y.—there are some interesting spline or keyway broaching operations. The illustration shows two of the tools for this class of broaching, both of which are used on the Lapointe Machine Tool Co.'s broaching machines.

One of these broaches, that shown on the machine, is for broaching six semicircular keyways spaced equidistantly around a two-inch hole. The unusual feature of this tool is that the broach is built up of sections, each marking the width of a combined tooth and space of the complete broach. These rings are assembled on a bar of soft steel, being keyed so that they will always remain in proper alignment. Should one of the teeth break at any part of its cutting edge, it is only necessary to insert a new section. The sections are all held firmly together by drawing them into place with a nut on the end of the broach arbor. In broaching, trouble is often experienced from having the finish end of the broach, that does the final sizing, wear under size. With this type of broach, however, when the finish sections wear small, new teeth may be substituted, and the tool is then as good as new. While expensive to manufacture, this style of broach has a long life, the one shown having been in use for the past three years.

Another broaching tool for cutting multiple keyways is the one that the operator is shown supporting in an upright position. This is made with six separate broaches that work together in broaching the keyways in a gear having a large center hole. If the broach had been made solid, it would have required a heavy piece of steel, which, of course, would have been very costly. The method used was to construct a head-block of low-carbon steel, having slots in which the six narrow broach-strips are hinged. This head-block is pinned to the end of the pulling screw of the broaching machine. The broaches are guided by a slotted block that is seated in the faceplate of the machine. This block may be seen located about half way up on the tool. The broach strips are made tapering as regards thickness from the teeth to the back. The difference in thickness between the two ends of



Two Types of Broaches for cutting Multiple Keyways

the broach strip agrees with the depth of the keyway to be cut. When the broaches are started they barely graze the gear, but as they increase in thickness at the cutting point, the broaching takes place. The slotted guide block prevents the broaches from springing away from the cut. The gear is put in place for the operation by slightly springing the tips of the broach strips together and passing the blank on and up to the faceplate of the machine.

Both of these broaching operations are handled very rapidly, the average time for broaching a gear 7/8 inch thick, with six keyways, being but two minutes. C. L. L.

* * *

AUTOMOBILE MANUFACTURERS IN THE UNITED STATES

The latest statistics of motor car manufacturers in the United States show that thirty-four states now have motor car factories, and the total number is 463. Michigan leads the list with eighty-six. Then follow in order New York with sixty; Ohio, fifty-two; Illinois, forty-seven; Indiana, forty-five; Pennsylvania, thirty-five; Massachusetts, seventeen; Missouri, sixteen; Minnesota, fifteen; Wisconsin, fourteen; California, thirteen; New Jersey, ten; Connecticut, seven; Washington, six; and the others with from one to four:

California	13	New Jersey	10
Colorado	3	New York	60
Connecticut	7	North Carolina	1
Delaware	2	Ohio	52
Georgia	1	Oklahoma	1
Illinois	47	Oregon	2
Indiana	45	Pennsylvania	35
Iowa	6	Rhode Island	1
Kansas	3	South Dakota	1
Kentucky	3	Tennessee	3
Louisiana	1	Texas	3
Maine	1	Utah	1
Maryland	4	Virginia	1
Massachusetts	17	Washington	6
Michigan	86	West Virginia	1
Minnesota	15	Wisconsin	14
Missouri	16		
Nebraska	1	Total	463

MULTI-PURPOSE AND ADJUSTABLE FIXTURES

EXAMPLES OF TOOLS FOR TURRET LATHE AND VERTICAL BORING MILL WORK

BY ALBERT A. DOWD*

WHEN pieces of the same type but of various sizes are to be machined on the turret lathe or vertical boring mill, it is sometimes desirable to design the tools and fixtures in such a way that they can be adapted to handle the different pieces, thus avoiding the necessity of providing a separate tool or fixture for each piece. Naturally, when the production is large, such a procedure as this would be unprofitable because the tools could only be used on one piece at a time, and a lot of pieces of one size might be held up for a considerable time waiting for a lot of another size to be machined. When, however, the work comes along in lots of 100 to 200 pieces, a great saving in tool cost can be effected by the use of adjustable tools and fixtures, providing the design of the parts is such that it will permit of following this practice. Much depends on the shape of the work to be held and its machining requirements.

There are instances when the desired results may be obtained by simple means, and there are other cases which require the application of considerable ingenuity in order to avoid complications in the design. Properly designed and carefully built tools and fixtures of the adjustable type are profitable investments on certain classes of work, and their advisability should be carefully considered when several pieces of the same general type are to be handled. The greatest forethought is necessary in designing fixtures of this kind, in order to make sure that every point for every piece has received proper consideration. There is probably no other type of fixture which requires so much care in its design, and for that reason the important points given herewith should be most carefully noted.

* Address: 7909 Ridge Blvd., Brooklyn, N. Y.

Important Points in Design

1. The number of pieces to be machined should be the first point considered, for this naturally has an effect on the design of the tools and fixtures.

2. The largest and smallest pieces in the group should now be selected, and the machine on which the work is to be done should be determined according to the sizes of these pieces. If the variation in size is considerable, it may be economical to do a part of the work on one machine and the remainder on another, in which case the fixture should be so made that it can be adapted for use on both machines. There may even be cases when the range of sizes is so great that two or more fixtures may be necessary, one of which can be used on one machine and the other on a different one; or they can be made interchangeable, providing the speeds on both machines give range enough to handle the work. These points should be carefully considered.

3. The accuracy required in the finished work must be noted and care taken to provide means of upkeep on surfaces or locating points that are subject to wear. There may be occasional instances, on work requiring extreme accuracy, when it may be necessary to provide means of adjustment for truing up the fixture so that it will always run perfectly concentric with the spindle of the machine.

4. Rigidity in work-holding devices and tools should receive careful attention; and overhang from the spindle, turret or cut-off slide should be kept down to a minimum, so that chatter will not result from lack of support. These points need more consideration when the tools and fixtures are to be used on the horizontal type of machine, than when a vertical machine is to be employed.

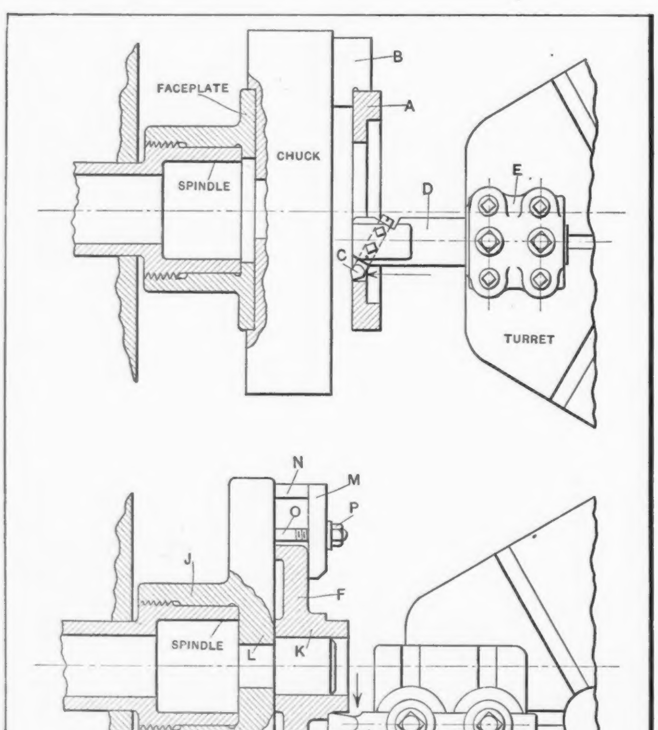


Fig. 1. Examples of Simple Work which can be held on Standard Three-jawed Chucks and Faceplates

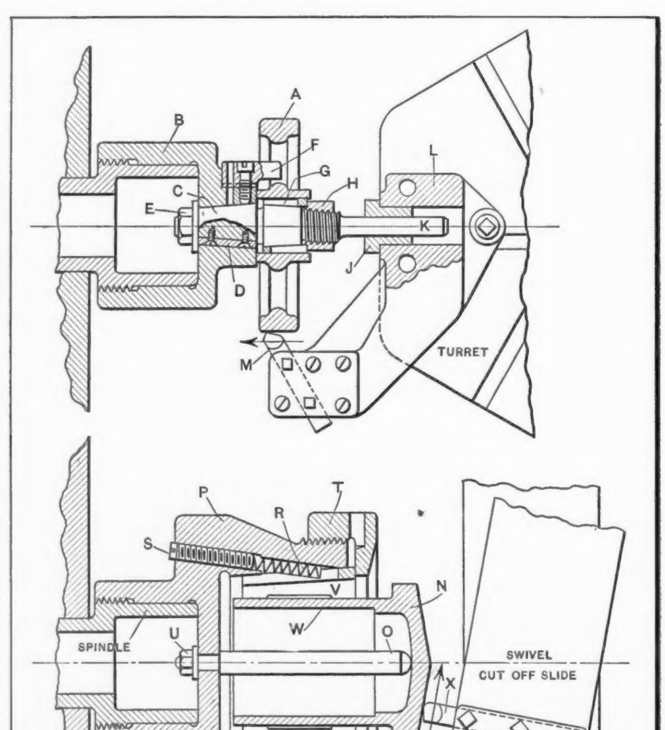


Fig. 2. Spoke Gear Blank held on an Expanding Bushing, and Pot Casting held in a Collet Chuck

5. Clamping devices for adjustable fixtures should be laid out (by means of a piece of tracing paper) for each piece to be handled, so that there will be no chance of clamps being too long, too short or improperly proportioned for some of the work. Errors are very likely to occur in this part of the design unless the greatest care is used; and there are also cases when the work varies in thickness as well as in diameter; so that this point must be carefully considered.

6. Provision for cleaning the fixture must be made, so that all locating points and surfaces will be readily accessible. If several sizes of studs or locating rings are to be used, they must be so arranged that chips and dirt will not interfere with the proper location of the work. They must also be placed so that they can be easily replaced or removed.

7. The adjustments which are necessary to provide for handling various sizes of work should be carefully studied, and suitable provision should be made so that the changes from one setting to another will always be uniform, so that variations in the work cannot occur on account of errors in adjustment. If necessary, setting gages can be made for the various pieces to be handled, or a separate set of screws or other adjustable locating members can be made for each piece and properly stamped to avoid mistakes. The nature of the work has a great deal to do with the method used to secure uniform adjustments, and specific cases will be noted as we proceed.

8. Convenience and rapidity of operation should be given consideration, and provision should be made for setting up the work in as short a time as possible. The fixture should be so arranged that the work can only be set up in the correct way, and it should be as nearly "fool-proof" as possible.

9. The cost of the fixture should be kept down to the lowest figure that is consistent with good design, because the number of pieces to be machined is comparatively small. If the work for which the fixture is made is of such a nature that it is not likely to be changed, a little more latitude is permissible; but as changes in design are always possible, it is advisable not to make an elaborate fixture.

10. The safety of the operator should always be considered, and projecting lugs, set-screws or other parts which might catch in his clothing should be eliminated from the design. Other points in design not mentioned in the foregoing will be specifically mentioned during the progress of this article; comments will be made, and faulty points criticised and discussed.

Adjustable Holding Devices in Common Use

The three- or four-jawed chuck is perhaps the most frequently used of all the holding devices which are adjustable to take various sizes of work. We have also collets of numerous kinds, which are adjustable within certain limits, and step chucks for work of a little larger size. For handling work in the rough state the three- or four-jawed chuck is adaptable to a great range of sizes, without any changes in the chuck jaws; but collets and step chucks require a change in jaws, or a re-setting if much variation is found in the diameters of different pieces of work. The step chuck is more frequently used for partly finished work, while collets are used for both rough and finished pieces—principally for bar work or something of a similar character. When a piece of work is to be made up in several sizes and is of a simple nature, such as the work *A* shown in the upper part of Fig. 1, it may often be handled to good advantage in a set of soft jaws *B* of a three-jawed universal chuck. These jaws are bored out on the machine to the exact diameter of the finished work, and when set up on the piece they present a good holding surface with sufficient accuracy for the ordinary run of commercial work. In the instance shown, the boring-bar *D* is held in the holder *E* mounted on a turret of the flat variety, which has a cross-feed motion to the turret in addition to the regular longitudinal movement. The tool *C* is adjustable both in the bar itself and in the turret movement, for boring the various diameters that are required.

It is well to note in passing that the soft jaws should be set up on a blank of some kind when boring them to size for a piece of finished work. This is necessary in order to make sure that all the back-lash has been taken out of the jaws.

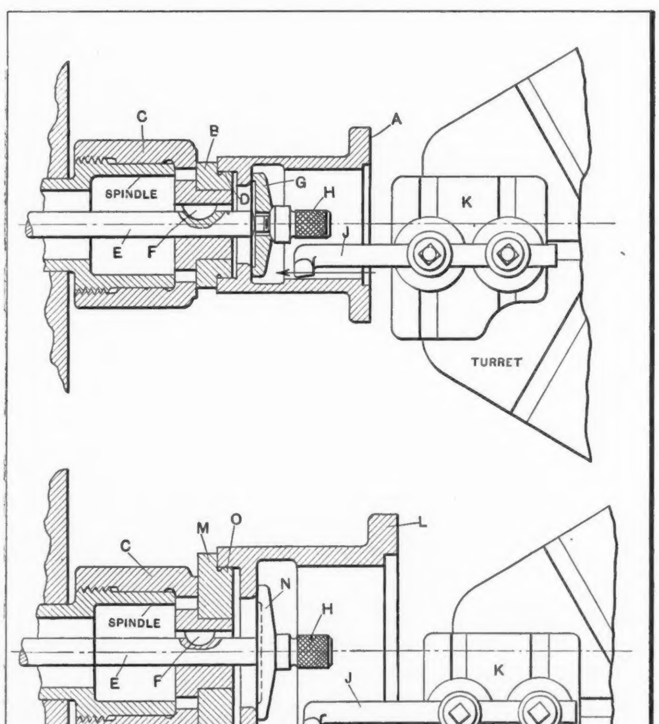


Fig. 3. Fixture for boring Pot Castings on Horizontal Turret Lathe; Different Clamping Collars are provided for Different Sizes of Work

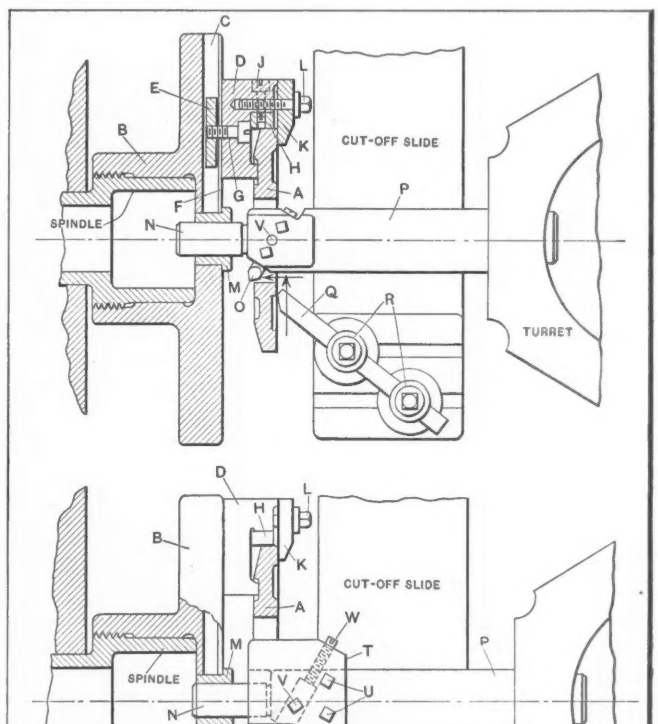


Fig. 4. Fixture for holding Bevel Gear Blanks of Various Sizes where Great Accuracy is required

It is obvious that the blank on which the jaws are set must be out of the way of the tool used for boring. Another point in connection with the use of soft jaws is that their accuracy is less to be depended upon when the work to be held is of large size, as the self-centering tendency is not so great in cases of this kind. The lower view in Fig. 1 shows a piece of work *F* previously bored and faced on one side, which is manufactured in three sizes, the largest of which is shown. In this case a standard faceplate *J* is screwed onto the spindle of the turret lathe and the work is located on the stud *K* which is turned to the diameter of the hole and finds a seat at *L* in the faceplate. The clamps *M* are tightened against the flange by nuts *P* acting on the T-bolts *O*, and supports *N* for the rear ends of the clamps are inserted between the clamps and the faceplate. A shovel nosed tool *G* is mounted in a holder *H* on the turret, and is used to cut the shoulder on the outside of the hub and face the end. Separate studs are provided for the various hole-diameters and the clamps may be readily adjusted in the T-slot. The two conditions shown in Fig. 1 are of a very simple nature and the method of handling requires little expenditure in tool or fixture cost.

Adjustable Arbor for Gear Blanks

The work *A* shown in the upper part of Fig. 2 is a spoke gear-blank that was made in two sizes, one of which was 8 and the other 6½ inches in diameter, with hub-holes 1¾ and 1½ inch in diameter, respectively. For holding these pieces, a special nose-piece *B* was fitted to the spindle, and the tapered portion *C* of the arbor was drawn back into it by the nut and washer at *E*, a key *D* being used to prevent turning. The expanding bushing *G* was split at six places, three from one end and three from the other, and it was crowded into the hub-hole by the washer *H* on the threaded portion of the arbor. In order to obtain additional rigidity the end of the arbor *K* was piloted into the bushing *J* in the special tool-holder *L* on the turret. The tool *M* turned the outside diameter of the gear and had sufficient adjustment to take care of the smaller diameter gear. As the frictional surface in the hub that was available for driving the gear against the cut was insufficient, a steel driver *F* was fastened to the hub on the nose-piece and furnished an excellent means of driving against one of the spokes of the gear blank.

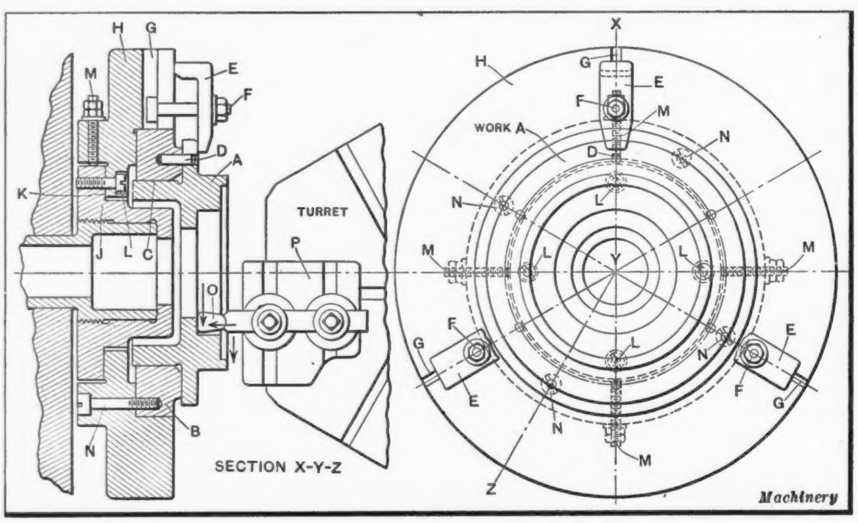


Fig. 5. Fixture in which Provision is made to compensate for Inaccuracy resulting from Misuse or Neglect

Special Collet for a Bronze Pot

The piece *N* shown in the lower part of Fig. 2 is made in two sizes and the variation on the outside of the shell is only ¾ inch. The work was held in a previous setting by the heavy portion of the flange *N* while the inside surface *W* was rough-bored at a single cut, and the outside carefully finished to size. No other accurately finished portion being available for holding the work, the outside finished surface was naturally used for the second setting. A special collet chuck *P* of cast steel was screwed onto the end of the spindle and bored to a taper to receive the split bushing *Q*. One of the bushings being somewhat heavy, it was cut out in six places *V* along the length so that it would expand more readily. Three coil springs *R* were made adjustable by means of the screws *S*, and these assisted in releasing the work, while the threaded collar *T* was used to close the collet jaws. A machine equipped with a swivel cut-off slide and a revolving turret toolpost *Z* was used to cut the taper on the end of the work, the roughing and finishing tools *X* and *Y* being swung into position as needed. A steel stop-pin *O* was drawn back into the fixture by the nut *U*, and the rounded end of this pin provided for the proper location of the work.

Adjustable Fixture for Several Pieces of Electrical Work

Fig. 3 shows at *A* and *L* the smallest and largest sizes of some pieces of electrical work which were to be machined on a horizontal turret lathe; and there were two intermediate sizes which were also handled on the same fixtures. A special nose-piece *C* is screwed to the end of the spindle and has a hub at its forward end on which the locating ring *B* (upper view) is fixed. The finished portion of the work fits this ring at *D* and is drawn back against it by the collar *G*; the rod *E* passes through the spindle and is pulled back by means of a handwheel at the end, while the key *F* prevents it from turning. The forward end of the rod is threaded to receive the knurled finger-nut *H* which has a spherical bearing in the collar *G* to equalize the pressure. In setting up the work, the piece is placed on the locating ring, the collar *G* is slipped over the end of the rod *E* and the knurled nut *H* is rapidly screwed on with the fingers, after which the handwheel at the end of the spindle is used to tighten the collar. A long boring tool *J* is used to rough out the shouldered portion of the work and to bore the bearing, and it will be noted that although this tool has considerable overhang it is well set up in the tool-holder *K*, and given additional strength by the use of two toolposts. The larger piece *L*, shown in the lower part of the illustration, is set up on the ring *M* locating on the surface *O*, which has been previously bored. A larger collar *N* is used for clamping this piece. With the exception of the locating ring and collar, all of the other parts of the holding device are the same as in the preceding instance. Additional rings and collars for the intermediate sizes make the fixture complete. It will be noted that there are two holes in the front of the nose-piece, which are so placed that a rod may be used to drive off the locating rings when changing over the fixture for another size of work. This fixture is simple and comparatively inexpensive, yet it is adapted for use on four pieces of work of different sizes and the changes required are of such a nature that they may be performed quickly so that there is very little loss of time. It may further be noted that the boring tool is the same in each case and that the adjustment for different diameters is obtained by the cross sliding movement of the turret.

Adjustable Fixture for Special Bevel Gear Blanks

The work *A* shown in Fig. 4 is a special bevel gear blank, and these gears are used in a great number of sizes on textile machinery. The pieces were held in the first setting by the interior and were machined on the side having the beveled surface and on the periphery; they were also partially undercut along the edge of the rim in order to provide a clamping surface during the second setting. Extreme accuracy was required in the work, and yet there were so many sizes to be handled that the construction of separate fixtures was deemed inadvisable. A special faceplate *B* was therefore designed having three radial dovetail slots *C* (upper view) in its face; and a small portion *F* of each of these slots was left straight to assist in locating the movable jaws *D*. These

jaws were made of steel and were radially adjustable to various diameters, being clamped in any desired position by means of the screws *G* and the dovetail shoes *E*. A number of sets of soft steel supplementary jaws *H* were drawn back into a seat on the main jaws by the two screws *J* and were bored in place to the diameter of the outside of the gear, the main jaws being set in place to an approximation of the correct diameter in each instance.

The clamps *K* were drawn down onto the finished portion of the work by means of the screws *L* in the jaws. A bushing *M* was set in the center of the faceplate and used as a guide for the pilot *N* of the boring-bar *P* which was held in the turret. The tool *O* was used to bore the hole while the tool *Q* faced the unfinished portion of the gear blank, the latter tool being held in two toolposts *R* on the cut-off slide. In handling some of the larger gear blanks a supplementary

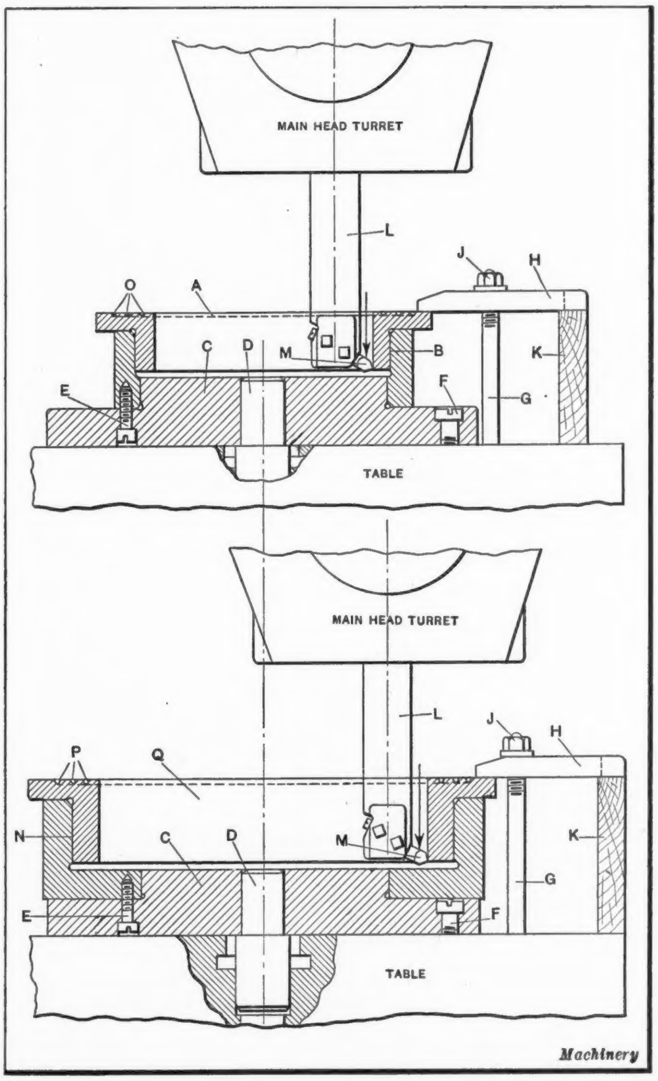


Fig. 6. Simple Fixture for holding Three Sizes of Steel Flanges, while boring, facing and cutting Packing Grooves

head *T* (lower view) was placed on the end of the boring-bar and held in place by the screws *U* on the flatted portion of the bar. This head gave good support to the tool *S* which was used for boring the larger sizes of gear blanks. This tool was held in place by the screws *X* and *V*, the latter passing through the hole provided for it in the bar. Fine adjustments were provided for in the backing-up screw *W* and the facing of the blank was accomplished by the same tool. This fixture took care of seven gear blanks of various sizes and gave very satisfactory results.

Adjustable Fixture with Means of Keeping in Truth

A fixture which is somewhat out of the ordinary and which may be adjusted to handle several sizes of work *A* is shown in Fig. 5. As absolute concentricity is required in the finished surfaces of the work machined in this fixture, it is essential for the fixture to be arranged in such a way that it can be trued up if it becomes inaccurate through misuse or neglect. The cast-iron nose-piece *J* is screwed to the spindle in the usual manner and the supplementary casting *H* is bolted to it with the four bolts *L*. The holes in this piece are slightly larger than the bolts so that small adjustments may be made. The flanged portion of the supplementary casting carries four headless set-screws at *M*, by means of which the ring can be trued up, and check-nuts are provided to secure a permanent setting of the fixture. The locating rings *C* are made in several sizes to take the various pieces that are machined in this fixture, and each of these rings is furnished with a driving pin *D* which enters one of the bolt holes in the work.

The screws *N* are set into the ring from the rear and are located in different places for the various rings. The fixture has three T-slots *G* in order that the clamps *E* may be con-

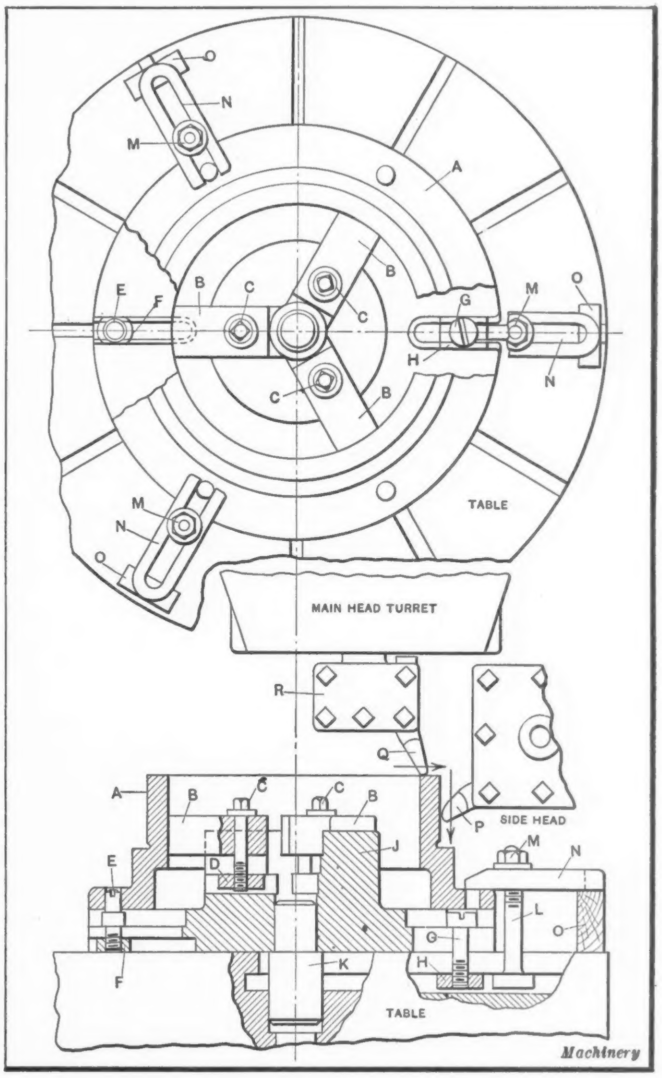


Fig. 7. Method of holding Three Sizes of Work which has been bored and faced and has had the Holes drilled in Flange

veniently adjustable, by means of the T-bolts *F* which enter these slots. The boring and shoulder work performed on the piece is accomplished by the shovel-nosed tool *O* which is mounted in the tool-holder *P* on the turret. This is an example of a fixture designed for standard work of various sizes coming through in small lots, and which requires extreme accuracy in machining. Attention is particularly called to the compactness of the design and the way in which it is built close in to the spindle so that although the fixture itself is heavy, there is so little overhang that the weight is of small importance.

Adjustable Fixtures for the Vertical Boring Mill

The table of a vertical boring mill is so arranged that it may be used either as a faceplate or as a chuck with provision for clamping in the T-slots when necessary. This is a distinct advantage in many kinds of work and especially

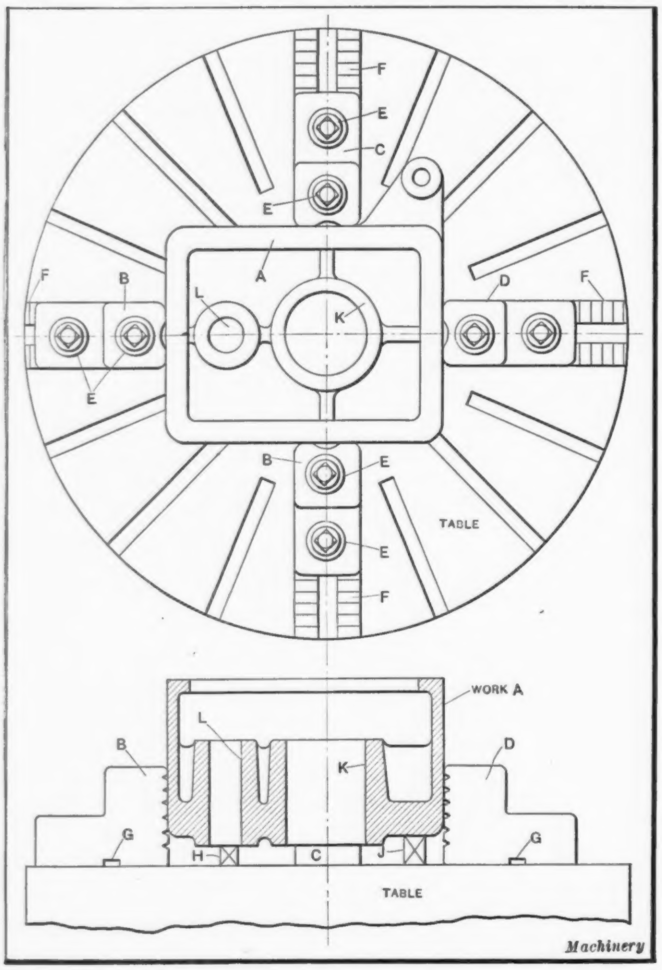


Fig. 8. Example of Use of Four-jawed Table for holding Rough Castings

so where a number of pieces of similar construction and different sizes are to be handled. Fig. 6 shows a simple fixture for handling three sizes of steel flanges *A*. The base *C* of the fixture is made of cast iron and is centered by a plug *D* in the table hole; and it is fastened down to the table by means of the screws *F* which enter shoes in the T-slots. In the upper illustration, the work *A* has been previously turned, faced and partially under-cut to provide for clamping, and it is held during the first setting by means of jaws on the inside of the flange.

On the second setting (shown in the upper illustration) the operations performed consist of boring the hole, facing the flange as far as the clamps, and cutting the packing grooves *O*. The locating ring *B* is slipped onto the finished portion of the base and is drawn down by the screws *E*. The clamps *H* are supported at the outer end by the wooden blocks *K*, and are drawn down onto the work by the nuts and washers *J* through the medium of the T-bolts *G* which are adjustable radially in the table slots. The boring-bar *L* is used for boring the interior of the flange with the tool *M*, while the side-head (not shown) faces the flange and cuts the packing groove. The lower illustration shows the fixture adapted for holding the largest piece *Q* which it handles. In this case the ring *N* is made of somewhat different shape so that it will locate properly on the finished portion of the base *C*. All other portions of the fixture are the same as in the preceding instance, the clamps *H* being moved outward in the T-slots a sufficient amount to take care of the work of larger diameter. The tools for boring, facing and cutting the packing grooves *P* are also the same.

Fixture with Adjustable Driver and Soft Internal Jaws

The work *A* shown in Fig. 7 is made in three sizes, the largest of which is illustrated. These pieces have been previously bored and faced, and the flange holes have been drilled in a jig. The base *J* of the fixture is made of cast iron and is centered on the table by means of the plug *K*. It is held down by three screws *G* which enter shoes *H* in the table T-slots, and it should be noticed that the slots in the fixture permit the T-bolts *L* to be moved inward to take care of work of smaller diameters. It is obvious that the screws *G* must either be moved inward when this is done, or else they can be placed at the extreme inner position and kept there at all times. The driving pin *E* is also arranged in a T-slot cut in the fixture, so that it can be moved radially to a position corresponding with the bolt holes; and the shoe *F* makes it secure in whatever position it may be placed.

Instead of using a locating ring, three soft jaws *B* are set in slots in the fixture base, and these may be clamped in place by means of the screws *C* which draw up on the shoes *D* in the T-slots. After clamping them in an approximately correct position, they are turned to the size of the interior of the casting. Attention is called to the fact that the outside portion of the hub in the base casting *J* is finished in order to facilitate calipering when turning the jaws. The clamps *N* are supported at their outer end by wooden blocks *O* and are drawn down on the flanged portion of the work by the nuts *M*. Radial adjustment of the clamps is obtained in the manner previously mentioned. The tools *Q* and *P* in the tool-holder *R* and the side-head, respectively, are used for facing and turning the outside diameter of the work. Adjustments for diameters are obviously obtained by setting the machine slide. This fixture may be made up at little cost, is easily adjustable and will take care of a great range of sizes. In addition to this, the accuracy obtained by its use leaves nothing to be desired.

Method of Using a Four-jawed Table as an Adjustable Fixture

When the nature of the work is such that a four-jawed table may be used, it is sometimes possible to obtain very satisfactory results on rough casting work without going to any expense whatever in the making of fixtures. An example of this sort is shown in the work *A* in Fig. 8. There were only twenty-five pieces of each size to be machined, and it

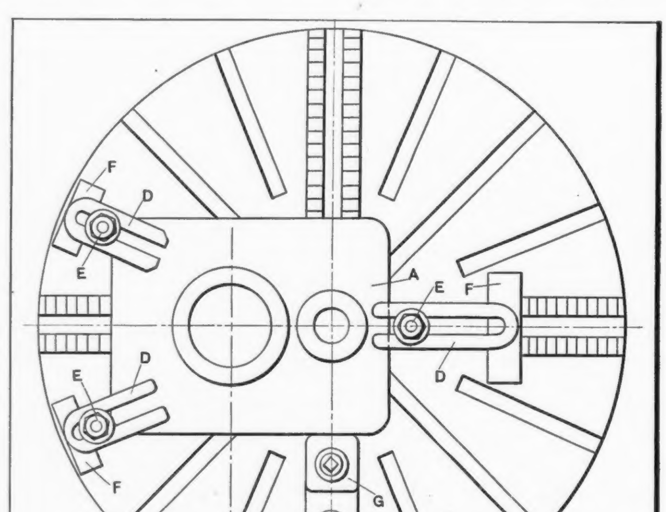


Fig. 9. Method of setting up Piece of Work shown in Fig. 8 ready for performing Second Series of Operations

was unlikely that others would be required for a considerable length of time, so that it was thought inadvisable to go to the expense of making even a simple fixture. Two operations were necessary on the piece, as the holes *L* and *K* had to be bored and both ends of the hubs faced, while the flange also required facing square with the hubs.

In the first setting the jaws *B* were set in such a position that they acted much as a vee would do in locating the casting; and after these jaws were set in the proper position, they were not moved until all of the pieces of one size had been machined. The work was set up on the steel parallels *H* and *J*, and the other two jaws *C* and *D* were brought up individually against the outside of the casting until it assumed the position shown in the plan view. The jaws were all set in the sub-jaws of the table, which were furnished with slots to receive the keys *G* on the under side of the jaws. They were held in place by the screws *E* which entered shoes in the slots of the sub-jaws. This method of handling may be adapted to a great variety of work. There is always a possibility, after the jaws *B* have been set in their correct position, that the operator may shift one or the other of these jaws unintentionally, thus destroying the setting. This may be obviated by marking the table at these points with a piece of chalk or in some other way which may suggest itself to the operator.

Second Setting of the Work

The method shown in Fig. 9 for setting up the piece for the second setting is quite out of the ordinary, but very good results may be obtained in this way when conditions will not warrant much expenditure for a fixture. The work *A* is placed on the table of the machine with the finished flange down and the unfinished hole *L* approximately central with the center hole of the table. The turret saddle is next traversed along the rail a distance *X* equal to the center-to-center distance between the two holes *L* and *K*. The dial clip on the handwheel is set to indicate this distance and the plug *B* having a shank *C* which fits the turret,

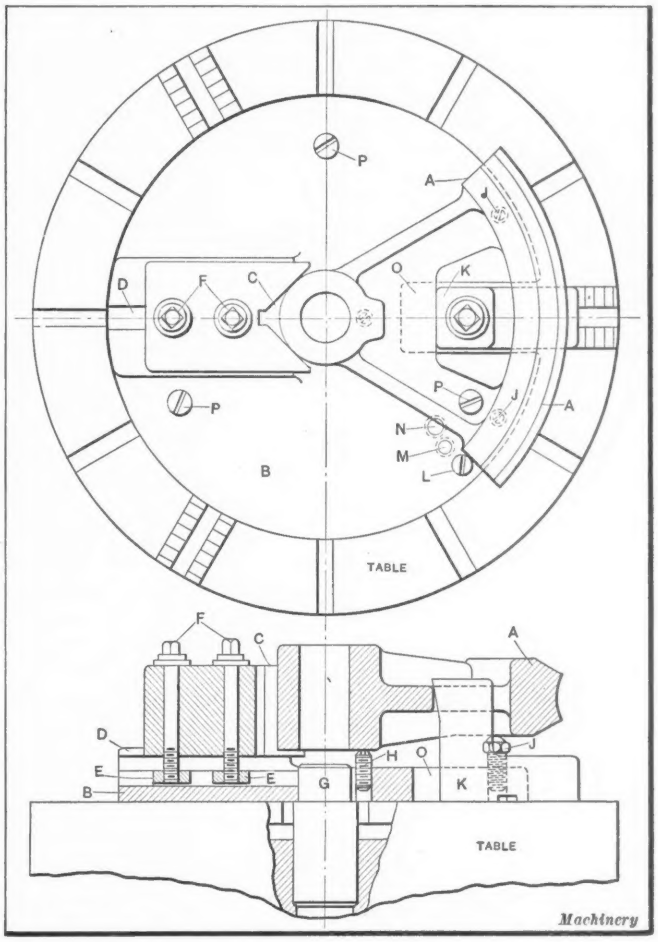


Fig. 11. Adjustable Fixture for holding Three Sizes of Bronze Worm-gear Sectors

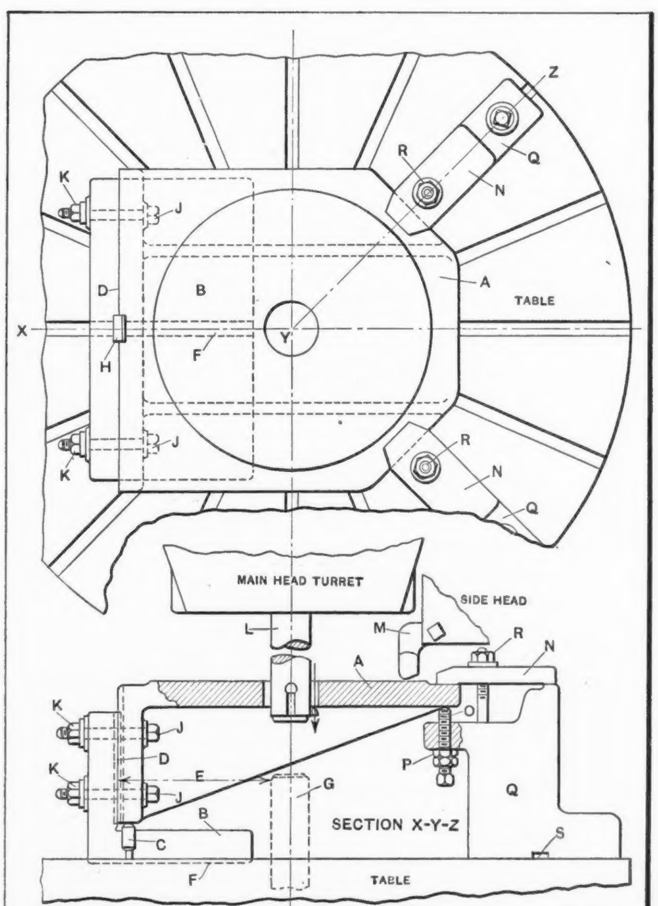


Fig. 10. Inexpensive Fixture for holding Two Sizes of Brackets while being bored and faced

is brought down until it enters the hole *K* of the work, thereby locating the piece correctly. The jaw *G* has been previously set to the correct distance and is not changed during this setting of the work. The piece is swung on the stud *B* as a pivot until the side of the casting brings up against the jaw *G*, and the three clamps *D* are then brought up into place and the work is clamped down on the table by means of the nuts *E* acting on T-bolts in the table slots. The ends of the clamps are supported by the wooden blocks *F*, as in the preceding instance. The turret plug is now withdrawn from the work which is then ready for machining. It will be noted that the jaw *G*, in addition to its function of locating the casting, also acts as a driver; and it will be seen that this method of handling requires no special fixture, nothing extra being needed except the locating stud *B*.

Adjustable Fixture for a Cast-iron Bracket

The work *A* shown in Fig. 10 is a cast-iron bracket which has previously been machined along the face *D* and has had the tongued portion cut approximately central with the cored hole at *Y*. Four holes have also been jig-drilled at *J*. Two sizes of these brackets were made several times each year in lots of ten or twelve, so that the expense of a complete fixture for machining each piece would have been excessive in view of the number of pieces produced. The following equipment proved satisfactory: An angle-plate *B* is tongued on the under side *F* to fit one of the table T-slots and is held down by screws (not shown). The distance *E* for the two sizes of brackets is easily determined by placing a stud *G* in the center hole of the table and locating the angle-plate *B* from it. The bracket is placed in position on the angle-plate so that the tongue *H* fits into the groove, and the bolts *J* are passed through the holes in the bracket and tightened by the nuts at *K*.

A little freedom is allowed in the bolt holes and the finished edge of the bracket rests on the pins *C*. Two special jaws *Q* are fixed in position on the table but may be adjusted radially when necessary to bring them into the correct posi-

tion for the other size of bracket. The jaws are provided with set-screws *O* which are adjusted to support the overhanging end of the bracket, after which they are locked by the check-nuts at *P*. The jaws are keyed at *S* to the sub-jaws of the table; and the clamps *N* are used on the unfinished portion of the bracket, being tightened by the nuts at *R* so that the surface to be machined is clear of interferences. The boring-bar *L* is used to bore the hole and the side-head tool *M* faces the pad. This is another example of a table being used with a faceplate having adjustable moving parts on it.

Adjustable Fixture for a Bronze Worm-gear Sector

The fixture shown in Fig. 11 was designed to handle three sizes of the bronze worm-gear sectors *A*. The base *B* of the fixture is centered on the table by means of the stud *G* in the center hole, and it is clamped securely by means of three screws *P* which enter shoes in the table T-slots. An adjustable V-block *C* is mounted on a finished pad and tongued on the under side to fit the slot *D*. All the jaws on the table chuck are removed and a special jaw *K* is substituted for one of them. This jaw is slightly under-cut on its face to assist in holding down the work, and at the same time it forces the hub of the casting up into the vee locating block. A slot *O* is cut in the base of the fixture in order to allow the necessary movement for this jaw. The hub rests on a headless set-screw *H* which is tapped into the base, and two other adjusting screws are provided at *J*. These are adjusted by means of a wrench after the jaw has been tightened. The set-screw *H*, however, remains set after it has been adjusted to suit the particular piece which is being machined. A driving screw at *L* takes the thrust of the cut and may be removed and placed in either of the holes *M* or *N* when used for the other pieces. In setting the V-block for another diameter of hub, it is only necessary to loosen the screws *F* and move the block radially to the desired position. The jaw *K* is readily set to size while the screws *J* and *L* are placed in holes provided for them.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Baker Ice Machine Case Affirmed

(Supreme) The United States Supreme Court has sustained the United States Circuit Court of Appeals in Bailey v. Baker Ice Machine Co. The suit was an interesting one from the fact that the Supreme Court in its opinion has discussed to a considerable extent the subject of conditional sales of machinery.

By a contract in writing, made at Omaha, Neb., October 14, 1911, between the Baker Ice Machine Co. and Grant Bros., the former agreed to deliver and install upon the premises of the latter at Horton, Kan., an ice-making and refrigerating machine for the sum of $5940, to be paid partly in cash and partly in deferred installments evidenced by interest-bearing notes. It was specially stipulated that the title to the machine should be and remain in the Baker Ice Machine Co. until full payment of the purchase price; that the machine should not be deemed a fixture to the realty prior to full payment; that in the meantime Grant Bros. should keep the machine in good order and insured for the benefit of the Baker Ice Machine Co.; that if default was made in the payment of the purchase price, the Baker Ice Machine Co. should have the right to resume possession and take the machine away; and that, in the event this right was exercised, the company should be reimbursed for all expenses incurred under the contract, should be compensated for any damage done to the machine in the meantime, and should be allowed a rental for its use equal to six per cent per annum upon the purchase price from the date of the installation to that of the resumption of possession. And it was further stipulated that the Baker Ice Machine Co. should have the right to file a mechanics' lien for the materials and labor furnished under the contract, and that no notice of a purpose to file such a lien other than that afforded by this stipulation, would be required.

The machine was installed. Grant Bros. became insolvent, leaving a large balance due on the purchase price of the machine. The Baker Ice Machine Co. took legal proceedings to recover possession of the machine, but possession of the machine was turned over to the receiver and sold by him for $2000. The interesting question of the case was whether the sale was a conditional one and who really should have title to the machine.

Justice Van Devanter, who wrote the opinion of the court, said in part:

"The court below held the contract to be a conditional sale, that is, one making full payment of the purchase price a condition precedent to the passing of title...... We are of the opinion that the contract was rightly held to be one of conditional sale." The money recovered from the receiver's sale of the machine was awarded to the Baker Ice Machine Co. The court said it had never parted with the title of the machine. *(Bailey v. Baker Ice Machine Co., 36 Sup. Ct. 51.)*

Employer s Duty to Furnish Well Lighted Premises

(South Carolina) Where a room was not lighted, so the danger from a machine could not be seen, a servant who was acting under the direct orders of his superior, who was present, did not assume the risk of injury; for it was not his duty to look out for latent dangers. *(Brown v. Piedmont Mfg. Co., 86 S. E. 815.)*

Defective Machinery Causes Suit

(Ohio) Where, in an action for damages for breach of warranty, it is claimed by the purchaser that the defective machinery covered by the warranty delayed the operations of the factory of which it is a part, and it appears from the evidence offered by the purchaser that other causes contributed to the delay, the burden is upon the purchaser to show, by a preponderance of the evidence, what part of the delay was caused by the defect in the machinery warranted and what damages, if any, were sustained by reason of the delay so caused.

Where machinery covered by a contract of warranty is purchased for the purpose of being used as a separate unit in a factory, and the operation of the whole factory depends upon this unit properly performing its part, both in quantity and kind, with the other parts, the purchaser cannot retain this article in place in his factory for an unlimited time after discovering that it is defective and recover as damages the daily loss in the operation of the entire factory, but must within a reasonable time substitute a machine, in place of the defective one, that will do its part of the entire work without delaying the operation of the other parts.

If the purchaser elect to retain such defective machinery as a part of his factory, notwithstanding its failure to produce the quantity of the product manufactured by the factory that it is warranted to do, his recovery is limited by the provisions of division "a," paragraph 1, of section 8449, General Code, to a recoupment in diminution or extinction of the price paid therefor. *(Lewistown Foundry & Machine Co. v. Hartford Stone Co., 110 N. E. 517.)*

A Question of Trademarks

(Wisconsin) While any person may manufacture and sell unpatented articles and use his own name in so doing, yet, if another has previously and rightfully made that name valuable as a trademark descriptive of the same kind of goods, he has a property interest which the courts will protect, and they will also prevent the subsequent manufacturer of the same name from using it so as to deceive the public.

Where plaintiff and its predecessor for many years manufactured plows, beginning with the simple walking plow, then making sulky plows, gang plows, and later plows to be drawn by tractors or engines, plaintiff acquired a property right to the use of its name with respect to plows, which defendant cannot infringe under the claim that the engine-drawn plow outfit is a separate and distinct tool from the single plow, a plow being a plow, whether drawn by animal power or tractor; hence defendant, though its corporate name was practically the same as that of plaintiff, was not entitled to use it on plows in such a way as to deceive. *(J. I. Case Plow Works v. J. I. Case Threshing Machine Co., 155 N. W. 128.)*

DESIGN AND MANUFACTURE OF DIES*

POINTS ON STANDARDIZATION OF DIE PARTS AND EXAMPLES OF DIE DESIGN

BY GEORGE H. HAMILTON†

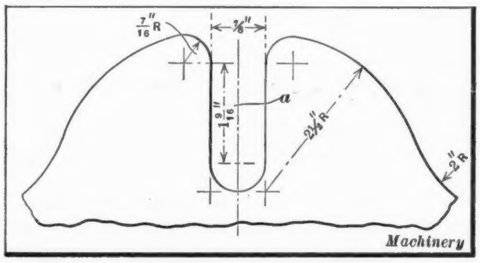


Fig. 1. Example of Standard Ear for Dies

Standardizing Patterns

A great deal of time and expense can be saved by standardizing die-shoe and punch-holder patterns, but this is not commonly done by manufacturers in the sheet metal or other lines of manufacturing. It is the usual custom to make the patterns as required without reference to what has been made previously; consequently, after the shop has been running for a few years a great many patterns have been made. If they are not standard and no record has been made of them, it will require perhaps several hours to look for a certain size shoe. Very often, after this time has been spent looking for the pattern none is found that will suit, so the foreman makes a sketch of the pattern required and has one made. It is entirely possible that there is one in stock that would suit if it could be found. There is no excuse for a condition of this kind although it exists in innumerable instances. This is the best argument for standard patterns and adequate records of same.

To standardize patterns, it is well to collect all the parts to be manufactured; this will give the designer or the master mechanic in charge of the work a good idea of the various sizes and shapes that will be required. If the product which is to be manufactured be of a great variety, it would be well to make an assortment of shoes starting from the smallest and increasing by about one inch in overall dimensions to the largest, making the slot not less than two inches in length as shown at *a* in Fig. 1. Very often there will be a number of special patterns to be made that are so different from the regular run of work that it would not be advisable to standardize them.

In order to keep a record of these special patterns, it would be advisable to make a sketch of each on the file cards, as shown in Fig. 2. In this way the designer or master mechanic can keep track of the patterns in stock without handling them. Fig. 3 shows a useful record form of standard die shoes and punch-holders and their numbers, as all patterns should be numbered. It is more convenient, as shown in Figs. 2 and 3, to allot a certain group of numbers to standard die shoes and punch-holders, and another group to special die shoes and punch-holders, as the special die shoes will be more numerous than the others. By this method, the pattern required will be easily found. Fig. 3, which records the standard die shoes and punch-holders, is the simplest form. The length is the distance from lug to lug, whether it is the longest way of the pattern or not.

SPECIAL PATTERNS

PAT. NO.	USED FOR	DESCRIPTION	SHAPE
P500.	Forming Adjustable Bracket	Die	
P501	" " "	Punch	
P502.			

Fig. 2. Special Pattern File Card

STANDARD PATTERNS.

PAT. NO.	USED FOR	LENGTH	WIDTH	THICK.	CHANNEL	LENGTH	WIDTH	DEPTH
S1	Die	6"	5"	2 1/4"				
S2	Die	7"	9"	2 1/4	+	9"	5 1/2"	1"
S3	Die	8"	5"	2 1/2"	□	5"	2"	1"
S4	Die	9"	6"	2 1/8"	—	9"	4"	1"

Fig. 3. Standard Pattern File Card

Standardizing Bolsters

It may appear to some managers that the standardizing of bolsters is of no value. Such is not the case, as it has been proved that if bolsters are not standard there is very often delay in waiting until one is made to suit certain dies. If the die shoes be made standard, then the bolsters should be standard also, allowing the die-setter to set any die in the press without having to drill special holes to accommodate it. Fig. 4 shows a good way to standardize bolsters. The holes are drilled about 1½ inch apart which enables the die-setter to put the die in either a lengthwise or crosswise position—whichever may be the most convenient for the operator in feeding the stock. It might be well to drill cross-holes at 45-degree angles, as there may be some dies which should be set at an angle rather than crossed or straight.

Another great saving of time is accomplished by having a proper place to store bolsters when not in use. Fig. 5 shows a very careless way of storing bolsters; this is not only in-

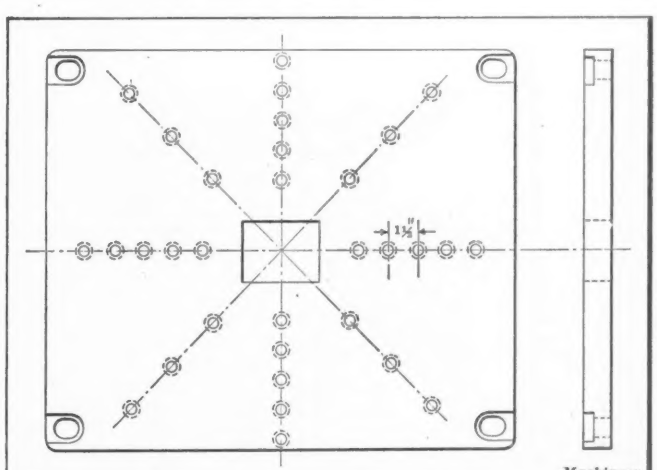


Fig. 4. Bolster standardized as regards Location of Screw-holes

* For information on dies previously published in MACHINERY, see "Some Punch and Die Troubles," February, 1916, and articles there referred to.
† Address: 38 Auburn Ave., S. E., Grand Rapids, Mich.

convenient but dangerous to employes. In the factory where this photograph was taken, several men have been badly hurt getting out bolsters. As these bolsters weigh from two hundred to eight hundred pounds, the extent of the injuries can easily be imagined. Although a portable crane is used as shown at *a*, Fig. 7, to lift the bolster from the pile, it is difficult to get at the bottom one without causing the others to slip, and a great deal of time would be lost in moving all the bolsters off the one wanted and putting them back again. Conditions of this kind are often found in press rooms, but because of the danger and waste of time involved they should not be tolerated by factory inspectors.

Figs. 6 and 7 show a strong and convenient bolster rack

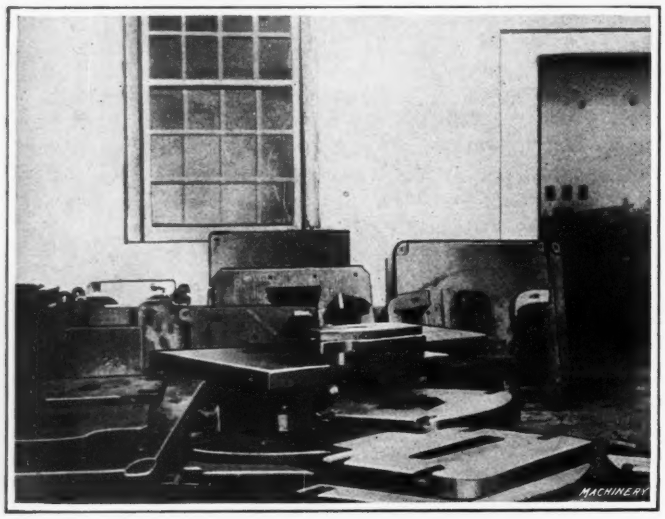


Fig. 5. Improper Method of storing Bolsters

which will pay for itself in a short time. This rack is made from $1\frac{1}{4}$-inch pipe with $1\frac{1}{2}$-inch heavy pipe at *a* and 2-inch extra strong pipe at *b*, Fig. 6, to act as rollers when taking the bolsters out. The portable crane *a*, Fig. 7, may be run up to the rack, quickly attached to the bolster wanted, and pulled out without disturbing any of the other parts. Two or more of the smaller bolsters may be put in the same divisions, the $1\frac{1}{2}$-inch heavy and the 2-inch extra strong pipe holding them separate and allowing one to be rolled out without moving the others.

Standardizing Parts for Dies

Detail drawings should be made of all small parts, such as piercing and blanking punches, button piercing and blanking dies and trigger stops. With this information, the designer would know at all times what sizes and shapes of parts were in stock. In the die repair department, also, it would not be necessary to carry such a large variety of these parts, thus reducing the repair parts to a minimum. Fig. 8 is a detail of the blanking punch *j*, Fig. 13. It will be seen that the dimensions are given and all other information that is neces-

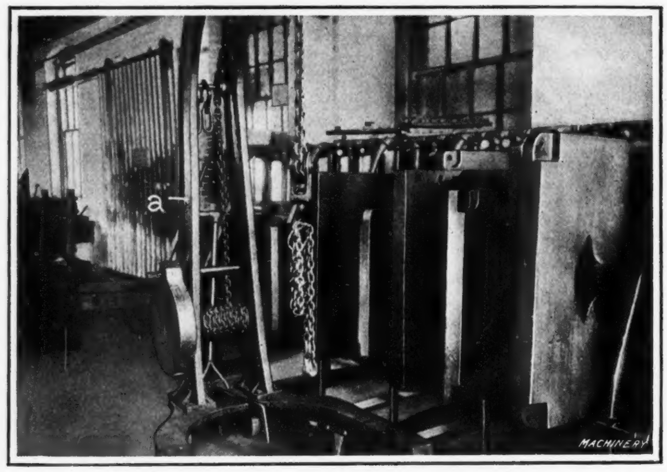


Fig. 7. Rack for Large Bolsters showing Crane by which they are lifted

sary for making this part. Although this acts as a blanking punch in this case, it will be readily seen that it could be used as a piercing punch in some other die, providing the size was correct.

Blueprints should be made from these details and placed in a loose-leaf ledger that is kept in the drafting department. The number of every die for which this part is used should be added on the catalogue and a new print made from it and put in the ledger, keeping the detail drawings always up to date. Any other method than detail drawings for preserving the original dimensions of small parts is inadequate.

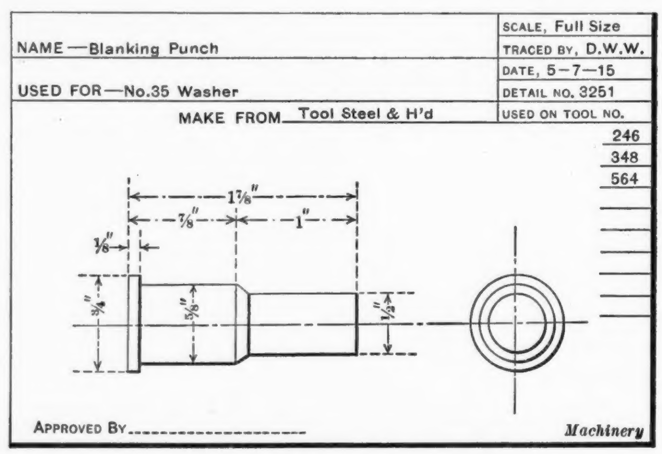


Fig. 8. Detail Drawing of a Standard Punch

The old practice of making new parts by dimensions taken from an old worn part is obviously very poor. A copy of these detail drawings may be kept in the die repair department and when a part is wanted, the detail may be sent to the tool-room and the part made from it.

Efficient Design of Dies

It is needless to say that too much thought cannot be given to the design of dies. There are a great many different ways of designing a die to do a certain piece of work. The first step is to choose which of the numerous types of dies to adopt. A piece such as shown in Fig. 9 has three holes, the holes at each end being embossed or countersunk. Two dies might be used to make this piece, the first being a blanking die and the second a piercing and embossing die. Then, again, it might be

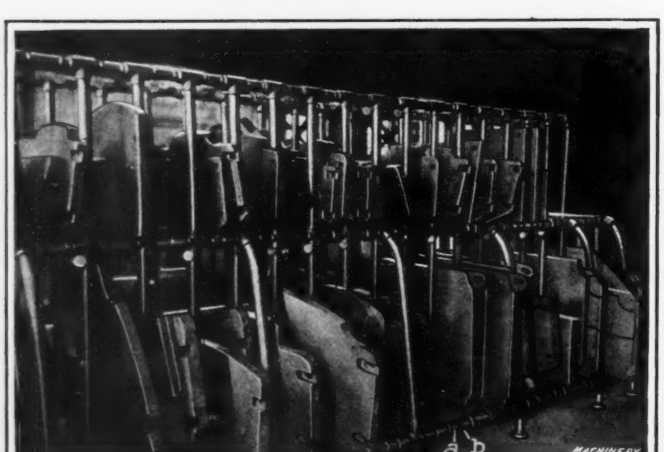


Fig. 6. Neat and Safe Method of storing Bolsters

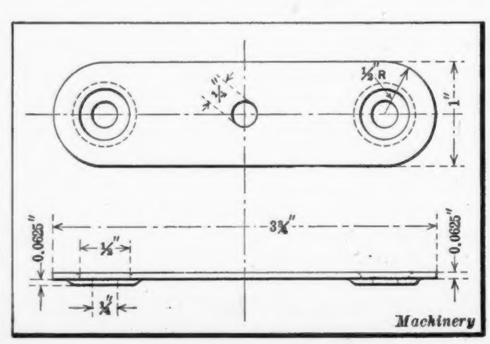


Fig. 9. Sample of Die Work

made in a compound die as shown in Fig. 10 or in a progressive die as shown in Figs. 11 and 12.

The first method suggested is out of the question, as this would require two operations, which is too slow. The compound die in Fig. 10 would do the work all right in one stroke of the press, but it would be very inconvenient for the operator to feed and gage the stock; moreover the die would be expensive to make and is, on the whole, not very satisfactory. The progressive die in Fig. 11 would also do the work in one stroke of the press, and at first thought might be considered the best and cheapest. This type of tool, however, has certain disadvantages. It would be necessary to cut the stock into narrow strips, which is not easily done either on a slitter or a shear. The difficulty lies largely in keeping the width uniform. The stock could easily be gaged and the scrap pushed through the die under the press, but the blank would remain in the die and require a kick-out or would have to be removed by the operator. This all tends to delay the operation and stamps this die as being inefficient.

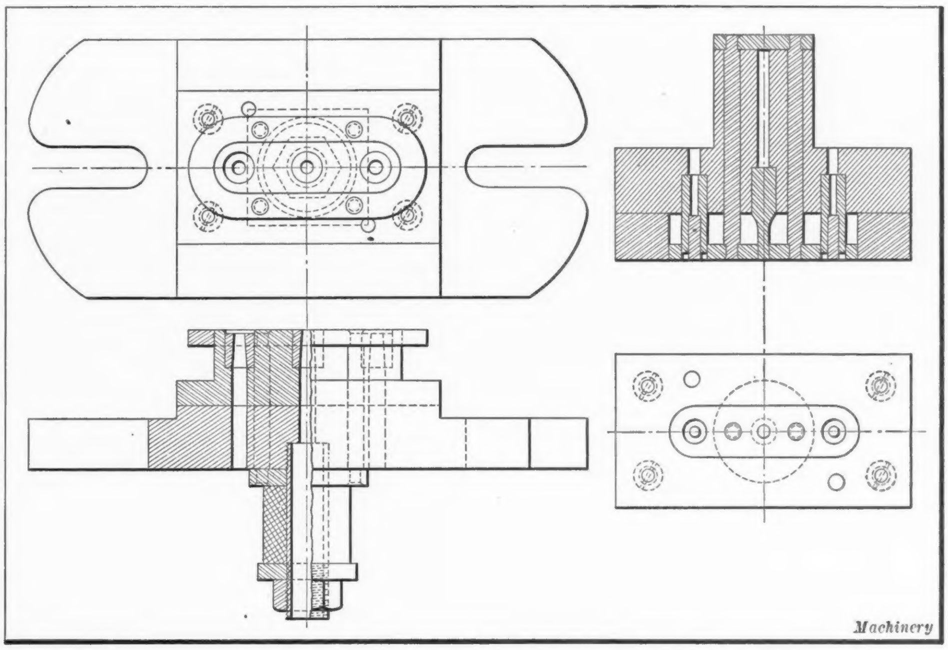


Fig. 10. One Die for making Part shown in Fig. 9

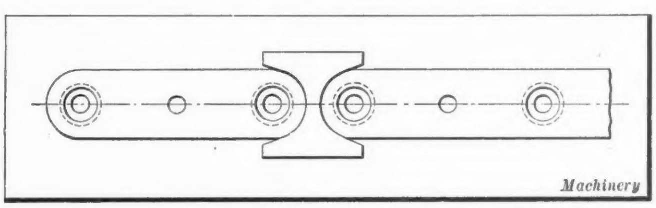


Fig. 11. Another Method of making Part shown in Fig. 9

The die shown in Fig. 12 would be the proper one to make for the following reasons: first, there is a piece made at every stroke of the press; second, the stock could be easily cut on a gang slitter or square shear, as it would not have to be exact in width; third, the stock could be easily gaged; fourth, the blanks and piercings would fall under the press; fifth, the scrap would pass through the die without interfering with the next blank to be made; sixth, there would be little scrap, there being only 1/16 inch on each side of the strip, as there is no web between the blanks; seventh, a chopper or scrap cutter could be put at the back of the die to cut the scrap as it comes out. Undoubtedly this would be the cheapest, simplest and most efficient die to make.

A Progressive Washer Die

The progressive washer die shown in Fig. 13 for making five washers from 11 gage cold-rolled steel at one stroke of the press needs no demonstration to convince one of its practicability. This is by no means a new type of die, but there are a few points about the design and construction that are worth mentioning. As will be seen by reference to the illustration, the trigger *a* gages the first two holes *b* that are pierced. This trigger has a spring which holds the stop down on the die while the first holes are being pierced; it is then raised on top of the stock by the operator as the stock is pushed forward, and the stock slides under it until the strip is finished. The trigger *d* is the second stop. It has a coiled spring *e* which holds the stop up continually. After the first two holes *b* have been pierced, the stock is pushed forward until the stop end of the trigger *d* enters the hole as the operator raises the end of the trigger to which the spring is connected. In this position the second two holes are pierced. The trigger *d* is used in this manner until the stock strikes the trigger *f* which has a spring *g* with a double action, holding the stop down and forward. This trigger, while it is made the same as *a* and *d*, must have play or side motion in the stripper equal approximately to the thickness of the stock, allowing it to spring on top of the stock when it is raised by the screw *h* at the time the punch descends. The screw *h* should be adjusted to come in contact with the trigger just after the punches enter the stock so that by the time the punches have passed through, the stop will have been raised and the spring *g* will force the stop on top of the stock, ready to drop in the next hole when the stock is pushed forward. This trigger, which works automatically, is used until the strip is finished.

The pilots *i* correct all errors in the triggers. They wear quite fast with the constant bumping of the stock against them, even though made of tool steel and hardened. This is a great improvement over putting pilots in the blanking punches, as they can be made larger and stronger. This has been proved in this die since it was first made. It will be seen by the holes at *j* in the blanking punches that this tool was originally fitted with pilots in the punches which were taken out and replaced by the pilots *i*. The guide pins *k* give much better results in diagonal corners when it is pos-

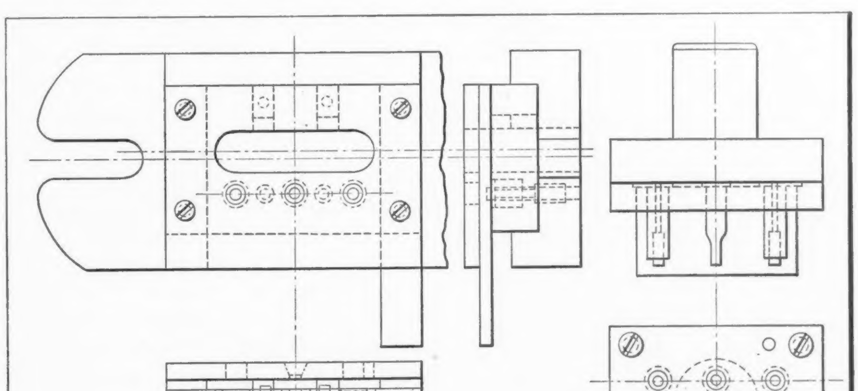


Fig. 12. Best Method of making Part shown in Fig. 9

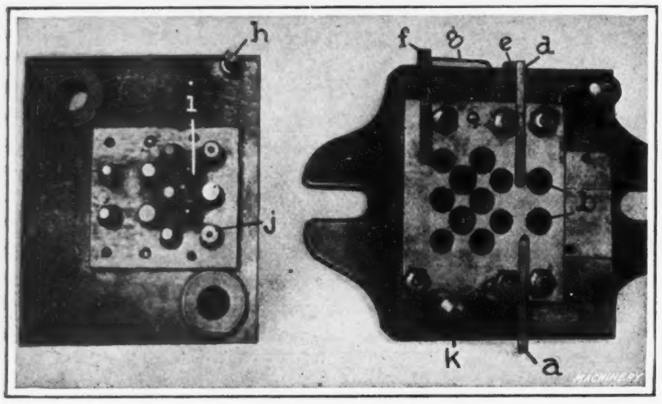


Fig. 13. A Progressive Washer Die

sible to put them there without reducing the production by interfering with the operator.

A Positive-action Cam-operated Forming Die

Very often there are irregular pieces to be formed that have to be shaped on three or more sides. In order to do this in a single-action press, it is necessary to use cams, especially if much pressure is required. The die shown in Fig. 14 is a positive-action cam forming die for forming the tube *a* to the shape shown at *b*. A piece of this kind looks difficult, but is formed nicely in a die of this type. The machine steel plate *c* has tool-steel jaws fastened to it at *d* and two rollers at *e*. These rollers are set into blocks which are attached to plate *c* for the cams *f* to slide between. There are fixed rollers set in the shoe below the movable rollers *e* which are not

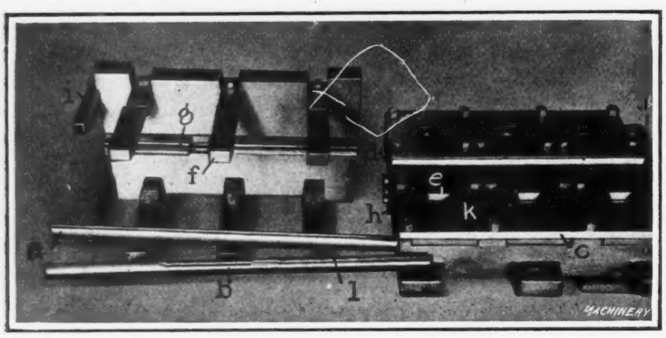


Fig. 14. Cam-operated Tube Forming Die

shown. Their mission is to back up the cams as they force the plate *c* forward. As the punch descends the cams go down between the rollers at *e* and force the jaws together, gripping the tube and collapsing it, while the punch *g* flattens the flanges *l*. As the punch ascends the cams open the jaws, leaving the work loose in the die so that it can be easily removed. This die has a positive action, there being no springs to get out of order. The cams are designed to close the die when the ram descends and open it when the ram ascends.

The jaws *h* which conform to the shape of the tube before being formed are operated by the cams *i*, gripping the tube before the sliding jaws *d* strike it, and holding it in the proper position while being formed. The gage is fastened to the die

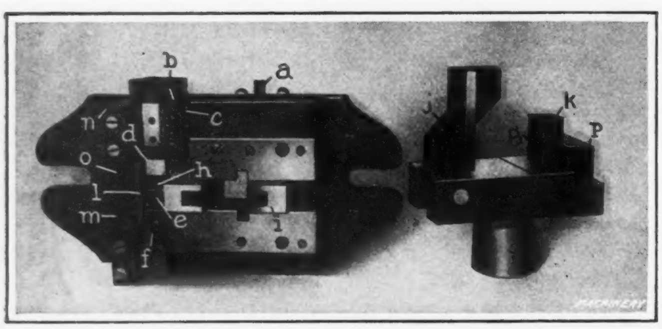


Fig. 15. A Cutting-off and Forming Die

at *j* and is adjustable to any length. The thin sheet metal plates *k* on top of the die prevent dirt from getting into the jaws.

A Cutting-off and Forming Die

The forming of a piece of sheet metal into a cylindrical tube in one operation is difficult to accomplish in a comparatively simple die. Generally, a mandrel is used around which to form a tube of the type shown at *a*, Fig. 15, but in this case it is not necessary. The die shown in Fig. 15 cuts off and forms one split tube *a* with each stroke of the press, which runs at 120 R. P. M. The tubes thus obtained are within 0.002 inch of being perfectly cylindrical. The stock is fed through the guide *b* which is cut out on the top so the stock is visible to the operator. One side of this guide has a flat spring held by the screws *c*, which holds the stock against

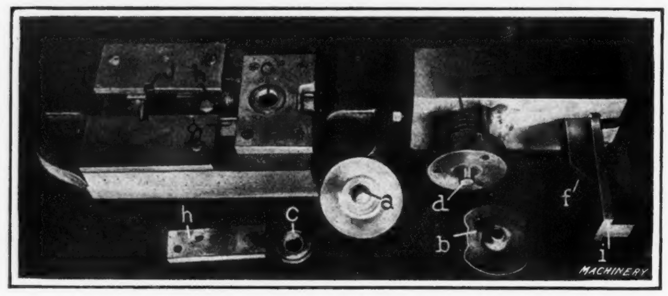


Fig. 16. Cam-operated Trimming Die

one side of the guide so that it will be cut off square. The part marked *d* is the cut-off block; *e* is the first forming die; *f* acts as the stop. The punch *g* cuts off the stock and forms it over *e* in a U shape, which shape is in proportion to the size of the finished tube. The finger *h* is a continuation of the slide and is made of tool steel, hardened. The roll retainers *i* are fastened to the slide by a rib and a small flat-head screw from the bottom. The roll retainers are fastened in this manner to act as a safety for the die in case any foreign condition arises such as a half blank being cut off by mistake and falling between the working parts. The blocks *i* being fastened in this manner allow the screws to break, thus saving some important part from being broken, the screws being easily replaced at a low cost.

While the stock is being cut off and formed over the die *e* by the punch *g*, the slide and finger *h* are held back by the cam *j*. As the punch ascends, the spring pin, not shown but indicated at *k*, in the punch *g* holds the work on the die *e*, stripping it out of the punch *g*. Then the cam *j* forces the

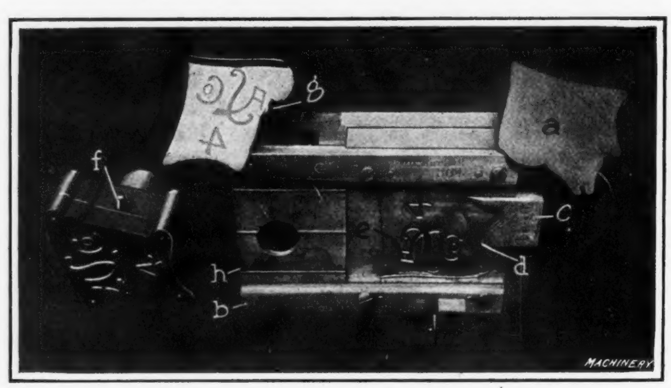


Fig. 17. Die designed for Speed of Production combined with Safety

finger *h* forward, pushing the work through the guide *l*, which is bell-mouthed to receive it, into the dies *m*. These dies are in the form of two semicircles, the lower one being fixed and the upper one sliding on pins *o* and held up by springs. The top die *m* is limited in its upward travel by the block *n*. The limit of this travel is the point at which the U-shaped blank will maintain an upright position between the upper and lower dies until the next stroke of the press. At the next downward stroke of the press, the top die *m* is forced down by the bumping block *p*, thus forming the tube. The tube is pushed out of the die by the next piece.

The press being set in an incline position, the tubes roll to the back of the press. In order to have the tube cylindrical, the metal must be set or compressed so that it will conform exactly with the shape of the dies *m*. The form in the dies *m* should be about 0.002 inch smaller in diameter than the size of the tube required, as the metal will expand this amount after the pressure is released.

The following formula will give very nearly the length of blank required:

$$L = \pi\,(1.5\,T + 0.002 + D)$$

in which T = thickness of stock;

D = inside diameter of tube.

For example, thickness of stock is 0.036 inch and inside diameter, 0.3125 inch. Then,

$(1\frac{1}{2} \times 0.036 + 0.002 + 0.3125) \times 3.1416 = 1.1577$ inch, and

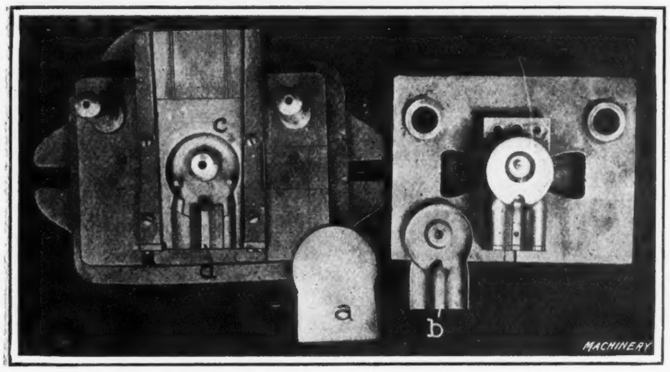


Fig. 18. Die provided with Removable Parts at the Points of Greatest Wear

the correct blank is 1.1563 inch. This was made of bright cold-rolled steel.

Cam-operated Trimming Die

A simple die is shown in Fig. 16 for shearing or trimming the end off the hub on the piece *a*. The surface must be smooth and free from scratches or cracks, as it has to be curled. The slightest crack or mark on the edge of the hub would start a crack while it was being curled. Before this die was made, a counterbore was used to smooth the edge, but it did not do the work satisfactorily. The piece of work *a* is placed on the die at *c* with the hub in the bushing which acts as a gage, the thickness of the bushing determining the length of the hub after being trimmed. As the ram descends, the punch *d* holds the work down tightly on the die by the

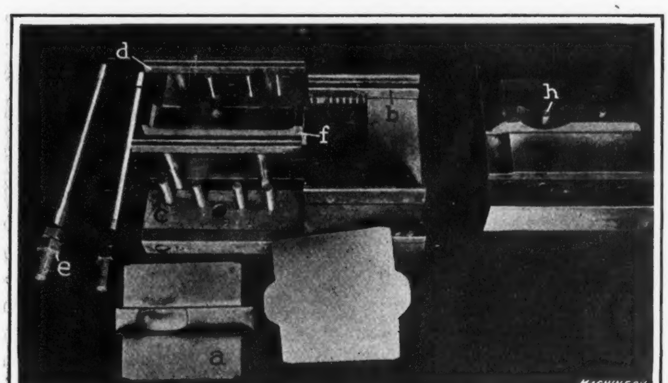


Fig. 19. First-operation Die provided with Means of ejecting Work

pressure of the coil spring *e*, while the cam *f* forces the slide *g* carrying the shear blade *h* forward and shears off the point of the hub. As the ram ascends the cam forces the slide back again in position for the next piece. The projections *i* on the sides of the cam slide in the notches in the ways *j*. The shear blade *h* should be a sliding fit under the shear die *c*, which is the exact length of the hub required. The punch *d* should be about 0.0015 inch shorter than the die plus the thickness of the metal. This gives a nice clean cut without any burr. This die is also commendable because of the safety

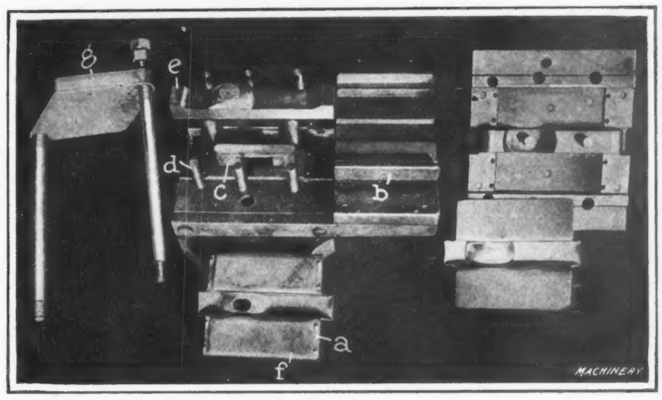


Fig. 20. Second-operation Die provided with Means of ejecting Work

with which it may be operated, a point which should never be overlooked in die design.

Dies which Increase Production and are Safe to Operate

It is just as essential to get the work away from a die rapidly as it is to place the work in the die rapidly. In Fig. 17 a die is shown which extracts the work the moment the punch ascends, this being accomplished by gravity, as the press is set in an inclined position. The blank *a* is placed on the chute *b* and slides down against the stop *c*, which is tapered down at the point *d* to allow the piece after being formed to slide over it easily. The pad *e* has strong springs

Fig. 21. Die Storage and Method of grinding Large Dies

under it which keep the piece up against the punch while it is coming out of the die; then the knock-out pin *f* in the punch, which is backed by a spring, pushes the piece off the die the moment the pressure between the pad and the punch is relieved. The ear *g* on the piece forces the knock-out pin *f* into the punch, putting the spring under tension as it is formed in the die. The chute *b* is carried out far enough from the

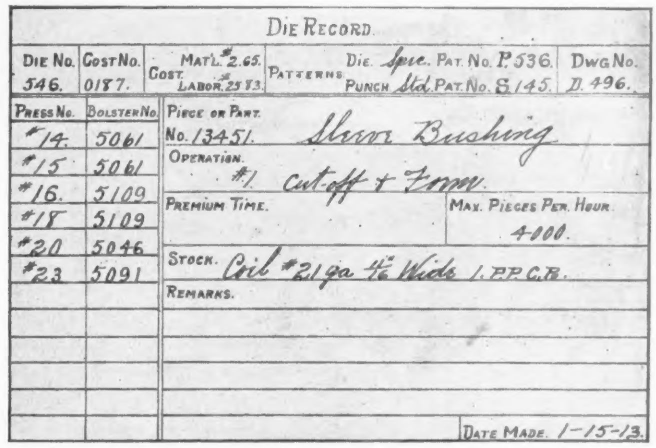


Fig. 22. Die Record Card or Sheet

punch so that when a man's hand is on the chute with his thumb under it his fingers will be a safe distance from the punch when it descends. With a chute of this kind the die should be practically accident-proof. The small bosses *h* on the chute are made to reduce the friction to a minimum.

Design that Reduces Maintenance

A very important point in designing dies is to consider the cost of up-keep and to incorporate replaceable parts in places where the most work is done. Fig. 18 shows a die with pieces of hardened tool steel inserted in the die proper that can be replaced when worn out. This die forms the piece *b* from the blank *a*, and when finished must be smooth and without wrinkles or scratches. As there is a lot of metal to be displaced, there is considerable wear on the die. The ring *c* and the block *d* receive practically all the wear; therefore they are inserted into the die proper which is made of tool steel and hardened. The strippers are removed in order to show the construction of ring *c*.

Extracting an Odd-shaped Piece from the Die

A unique forming die is shown in Fig. 19 which forms 16-gage cold-rolled steel as shown at *a*. A die designed as shown for an inclined press needs no safety guards on the press, as it is accident-proof in every respect and the production is very rapid. The blank is placed on the chute *b* at the front of the die and slides into the die by gravity, being guided between the gage pins *c* onto the slides *d* which act as knockouts as well as slides. The slides *d* are adjusted to the height of the chute *b* by the pull-rods *e* which are screwed to the punch-holder and pass through the die and bolster plate. This pulls the slides *d* up when the ram of the press ascends and allows the piece to slide off to the back of the press. The pad *f* carries two pins (not shown) which pass down through the shoe and bolster and rest on a large coil spring that abuts against the plate attached to the pull-rods as shown at *g*, Fig. 20. This forces the piece out of the die, and the slides carry it clear of the pad. Two pins *h* in the punch backed up by springs force the piece off the punch.

Second-operation Forming Die

Second forming dies are generally more difficult to design than first forming dies because the piece to be fed into the die is of irregular shape and will not slide into the die as easily as a flat blank. The tool shown in Fig. 20 is the second forming die for the piece shown in Fig. 19. It is of similar design and operates in practically the same way. On account of its shape, it is difficult to make a die that is accident-proof for piece *a*. The piece is placed on the chute *b* and slides onto the knockouts or slides *c*, the pins *d* acting as gages and stops. The pad *e* is adjusted low enough to allow the piece to slide over it. As the ram ascends, the pad *e* forces the piece out of the die, then the slides *c* carry it up until it clears *e*. The edges of the piece at *f* are turned up in this operation, making the blank narrower, which allows it to slide between the pins *d* to the back of the press.

Care of Dies

The care of tools and dies in the tool storage is a very important factor. Fig. 21 shows a corner of a tool storage, and it will be seen that the dies are arranged on racks built especially to hold them. Every die should have a particular place which should be numbered the same as the die. Then when the die is returned to storage, it can be easily put back in the proper place, where the man in charge can find it without undue delay.

Fig. 21 also shows a portable grinder *a* with a flexible shaft and revolving table *b* on which to grind large dies. As the motor is on a revolving base *c*, the workman is enabled to move the wheel and die to any position without lifting them or stopping the motor. This equipment is very valuable in a die storage, especially where there are large dies. The revolving table is very handy for inspecting the dies after they come from the press room. All dies should be inspected after being used and before being stored away so they will be ready for use when next wanted.

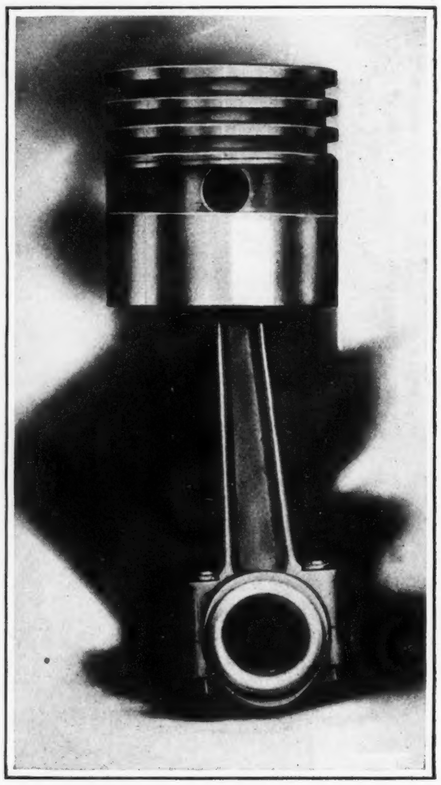
Die Record

A record should be kept of all dies made, and the best record is none too good. The card system is the simplest. Fig. 22 shows a die record which is practically complete and needs little explanation. The name of the part, operation, gage of stock, die cost, pattern and drawing numbers, bolster plate numbers and the numbers of the various presses on which the die may be used are all included.

* * *

MAGNALITE PISTON AND CONNECTING-ROD

The development of motor car engines is in the direction of lighter reciprocating parts and higher speeds. The accompanying illustration shows a "Magnalite" Ford piston and connecting-rod assembly made by the Walker M. Levett Co., 10th Ave. and 36th St., New York City, which weighs complete only twenty-six ounces. The stock cast-iron and steel assembly weighs seventy-four ounces. The difference in weight, forty-eight ounces, multiplied by 4, the number of cylinders, equals 192 ounces or twelve pounds saved in total reciprocating weight.



"Magnalite" Piston and Connecting-rod

It is claimed that the substitution of these pistons and connecting-rods for the stock cast-iron and steel assembly makes an increase of from 25 to 30 per cent efficiency in any Ford motor. The horsepower is increased and the fuel consumption materially reduced. Vibration is eliminated almost entirely. No babbitt is used for the bearing of the crankshaft end of the connecting-rod, the "Magnalite" alloy being used in its place.

* * *

AMERICAN MUSEUM OF SAFETY ANNUAL MEETING

The annual meeting and banquet of the American Museum of Safety was held at the Waldorf-Astoria Hotel, Thursday evening, February 3. Elmer A. Sperry, inventor of the gyroscope compass and stabilizer, briefly described his invention and the manner in which it is applied to stabilize aeroplanes and reduce the rolling of ships. The *Scientific American* medal was awarded to Mr. Sperry for the most efficient safety device exhibited at the Museum. The Travelers Insurance medal was awarded to Wilbur C. Fisk, president of the Hudson & Manhattan Railroad Co. The Louis Livingston Seaman medal was awarded to William Armstrong Fairburn, president of the Diamond Match Co., and the Edward H. Harriman memorial medal to the Cincinnati, New Orleans & Texas Pacific Railway Co. The silver and bronze replicas were awarded to the Norfolk & Western Railway Co. and John O'Brien, switchman and conductor, of the Chicago & Eastern Illinois R. R. The Anthony N. Brady memorial medal was awarded to the Union Traction Co. of Indiana, and the silver and bronze replicas to Harry N. Nicholl, general manager, and John Hancock, motorman.

OXY-ACETYLENE WELDING PRACTICE*

GENERAL CONSIDERATIONS AND DIFFICULTIES MET WITH IN OXY-ACETYLENE WELDING

BY S. W. MILLER†

IT SHOULD be understood that what follows is written, not for the purpose of discouraging anyone who is considering the use of the apparatus, but in order to explode the ideas which frequently exist, and which unfortunately are frequently cultivated by salesmen and advertising matter, that it is an exceedingly simple matter for anyone to learn to do good work by oxy-acetylene welding in a short time, and that by following printed instructions, anyone can become expert. These fallacies are responsible for many disappointments, and the apparatus and method have been denounced many times, when the whole trouble lies in the lack of experience and knowledge, even where the apparatus is first-class and adapted to the purpose.

In his thirty years' experience with mechanical matters of many kinds, the author has not seen any process so apparently easy as the handling of any oxy-acetylene welding torch by an expert welder. It certainly looked to him, when he first began to study the subject, almost as easy as the proverbial "rolling off a log." He soon discovered, however, when he took a torch in his hand, that what appeared so easy, was in reality a complicated matter, comprising, among other things, melting the metal, securing a good weld, adding metal and flux, keeping the melted metal from running away where it was not wanted, preventing hard spots, getting sufficient—but not too much—metal in the weld, avoiding pin holes and strains in the weld, keeping the parts in line, and handling the heated pieces. Besides all this, no two metals were amenable to the same treatment, and still worse, different pieces of the same metal required vastly different methods to handle them successfully. There are two examples of this that the writer recalls. The first was a three-throw crankshaft, with bearings about 3½ inches in diameter, which had the coupling flange, about 8 inches in diameter and 1½ inch thick, broken off square at the end of the end bearing. The material was cast steel, and the shaft was very old, probably twenty-five years. The flange was bored out to within 1/32 inch of the size of the bearing, leaving just enough to set it by, some of the metal was melted down to tack it, and an attempt was made to proceed by using regular steel welding wire, but this could not be done. Several different makes of cast steel were tried without success. It was finally necessary to melt down enough of the flange to extend entirely across the end of the bearing, about 5/16 inch deep, and fill the rest with cast iron. There was no time to experiment, as an important ferry was tied up. At the time, some doubt was entertained as to the strength of the weld; but as it has lasted for three years, and as the break was probably caused by the timbers holding up the driving shaft (which was coupled to the crankshaft) giving way due to decay, there will probably be no more trouble.

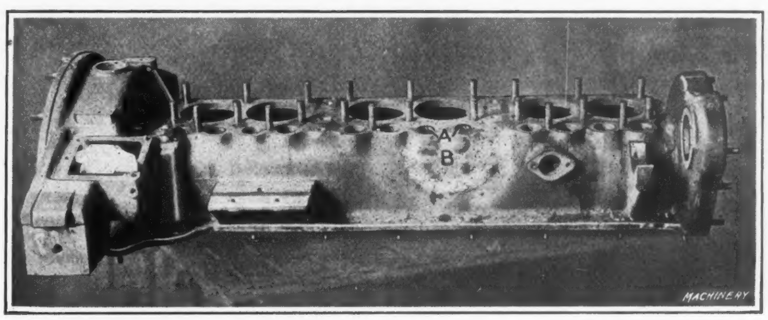


Fig. 1. Crank-case in which Shrinkage Strains had to be overcome in Welding

The other case was a casting, apparently of brass, and weighing not more than three pounds. As is customary at the plant where the work was done, rolled tobin bronze rods were used to weld it, but without success. The writer himself then tried, and found the melting points of the casting and tobin bronze so different that a tip heavy enough to melt the casting would blow the tobin bronze away before it could amalgamate with the casting. Fortunately, there were on hand some manganese-bronze sticks with a very high percentage of copper, which had been used experimentally, but were not suitable for ordinary work, and these proved satisfactory. Evidently the casting was a bronze with a high percentage of copper.

Requirements of a Welder

It is true that some men become more proficient in the art in a shorter time than do others; but even with every facility at hand—the welding torch is not all that is needed by any means—much experience is needed to become an all-around welder. The average good machinist would require at least one year in a repair welding shop, before he would be competent to take care of all kinds of metal and the various jobs that come in.

One of the principal qualifications is ingenuity. The welder must never admit to himself the impossibility of any job. Whether it will pay to do it is another question, although it is frequently the determining one. A heavy weld in a cheap casting is possible but uneconomical, and it therefore should not be done unless loss of time in getting a new piece, or some other consideration, outweighs the purely financial one. Careful thought and planning may make a job financially possible, where the ordinary methods would result in the work not being done at all or being done at a loss. Ingenuity is required for such thinking and planning; and from it follow new methods, easier and cheaper, which result in an increase in knowledge and ability, and in the advancement of the art.

It is not necessary for a man to follow any special trade in order to become a good welder; in fact, some knowledge of many trades is necessary, and the more known about them the better the welder is equipped. He should be somewhat of a machinist, blacksmith, boilermaker, patternmaker, molder, stationary engineer, electrician and draftsman. He should have considerable knowledge of the construction and operation of automobiles, gas engines and farm machinery. An acquaintance with contractors' machinery and methods of all kinds is valuable; and any mechanical experience that may have fallen to his lot is certain to be used sooner or later. A knowledge of the principles of the strength of materials is very useful in deciding how to reinforce a weak part in the best manner. For instance, it is common for a customer to request that his automobile frame be strengthened by welding a flat piece to the web of the channel inside, when equal strength with less weight and expense may be obtained by welding a piece to the inside or outside—preferably the latter—of the bottom flange, if that is where the tensile strain comes.

It might seem that anything beyond mere welding is none of the welder's business; but experience proves that in many cases if a welded piece breaks, customers blame the welder when full information shows that the fault is in incorrect construction or assembling. In many cases it is probable that if the original stresses are put on the parts repaired by welding, breakage will again occur, and the work will be criticised adversely. One trouble that frequently arises, or rather a condition which causes trouble, is the inability or failure of the welder to discover the cause of breakage.

At first sight it would appear that this really does not concern him, but when further consideration is given to the matter it will be seen that it is exceedingly important to know

* For information previously published in MACHINERY on oxy-acetylene welding, see "Oxy-acetylene Welding of Aluminum" in the February, 1916, number, and articles there referred to.

† Address: Rochester Welding Works, Rochester, N. Y.

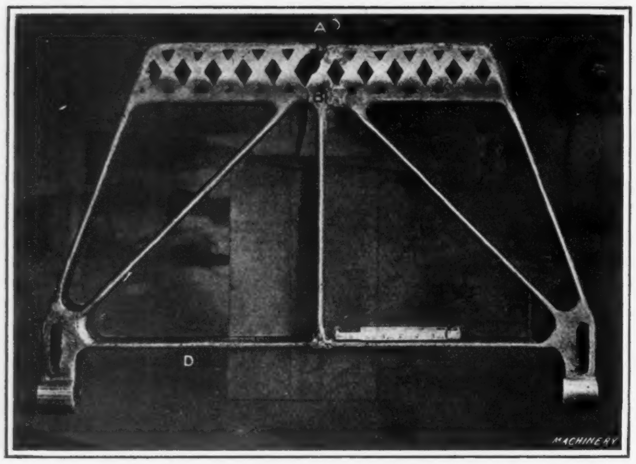


Fig. 2. Foot-treadle illustrating Difficulties in Welding

why a piece breaks. For example, the author frequently runs across cases where the piece is too light, and if this is the cause, it is certainly not fair to the customer to continue to weld the piece, unless he is made aware of the situation and advised that it will be cheaper and more satisfactory to have the piece made heavier, or made of steel instead of cast iron, for instance. Not only is it unfair to the customer to continue to weld a piece that is too light, but it tends to bring the process into disrepute, because the statement is sometimes made (although in the case of proper welding without any basis) that while the metal at the weld is strong enough, the original piece is damaged just outside of the weld. The reason for this kind of breakage is generally that the piece is too weak, although in the case of some metals, such as malleable iron, it is very easy to damage the metal outside the weld, as will be explained later. Aside from the above points, proper advice to a customer creates a feeling of friendship and good will that is an important business asset; so that it is both fair and politic to give ones customer the best advice that is at ones command.

The writer remembers one strange case which may possibly be duplicated in the experience of others. A piece of cast iron had been welded several times, never breaking in the same place. When it was returned the next time, inquiry was made as to the advisability of rewelding it, and it was stated that the piece was so located in the machine to which it belonged as to be the weakest part, so that if any excessive strains were to occur, this piece would break. The total number of welds eventually made in it was fourteen, and the superintendent of the factory operating the machine later stated that the piece had been thrown away, as he was afraid that it was too strong to answer the purpose, inasmuch as there was very little left of it but welds.

Training of Welders

One really serious obstacle to the rapid development of oxy-acetylene welding in all branches is the difficulty of obtaining welders, and this is frequently and successfully urged against the purchase of apparatus. The Germans have overcome this difficulty by establishing welding schools, where not only workmen, but foremen, superintendents and managers receive both theoretical and practical instruction. It is not believed that such work should be done by the government here, but the manufacturers of welding apparatus should, for their own good, take such steps as would enable schools to be maintained. This is a large subject in itself, and cannot be discussed here, except to say that Germany is far in advance of this country in the development of oxy-acetylene welding, largely because of such instruction, and it is believed that a perfectly feasible plan can be readily developed to overcome the present deplorable lack of educational facilities here. Whatever system of education or training be adopted, it is essential that the welder be impressed with the importance and necessity of being absolutely honest, not only with his employer but with himself. There is no credit to anyone in having a piece returned with a defective weld, and a properly trained foreman can instantly tell if carelessness caused the defect. Two or three instances of such work should condemn a welder almost beyond redemption. Aside from this, it would be a serious matter to the average man to feel that any defective work he had knowingly done had resulted in injury to any of his fellow-men. Such accidents have occurred, and show clearly the need of proper education and the most rigid code of honor on the part of the welder.

To obtain competent welders is not so difficult in a shop where the work is largely of one kind—thin sheet metal, for instance. In this case, the men become almost unbelievably expert in a comparatively short time, and far more so than a good all-around man would be on their special work; but such a specialist is of practically no value in a repair shop, where he would have to handle not only all sizes of pieces, but all kinds of metals. The writer has found that the only possible way is to employ a man who knows something about the principles of the art, and to teach him, not so much how to weld, but how to do the work so that as little machining or other finishing as possible has to be done after welding, and so that the piece can be used after being welded. The average welder pays little if any attention to anything except welding, and if he secures a sound weld, he believes he has done his full duty, and feels somewhat aggrieved if his attention is called to the fact that the part is out of line or full of hard spots, or has some other defect so that it is difficult if not impossible to use it. It is possible, however, to avoid machining in many cases by care on the part of the welder. For instance, a frequent accident to an automobile crank-case is a break through the side. No machining should be needed in such a case, and the faces and bearings should be just as true after the welding as before. It is admitted without argument that this is not commonly done, but it should be. Again, a stamping press frame, broken through one of the uprights, even if the section is as large as 4 by 16 inches, should never have the crankshaft bearings out of line with the platen more than 0.010 inch, and good welders repeatedly weld such pieces with less than half this error.

It is also strongly recommended that the superintendent in a shop doing welding himself learn to weld; not with the idea of doing the work, but so that he may be able to check the men as to the quality of their work and to decide how the work should best be done. It is easy to deceive a person who cannot weld, even when he is watching the work.

Wages of Welders

A good welder is worth good wages. It may seem needless to call attention to this fact, but a proper consideration of the

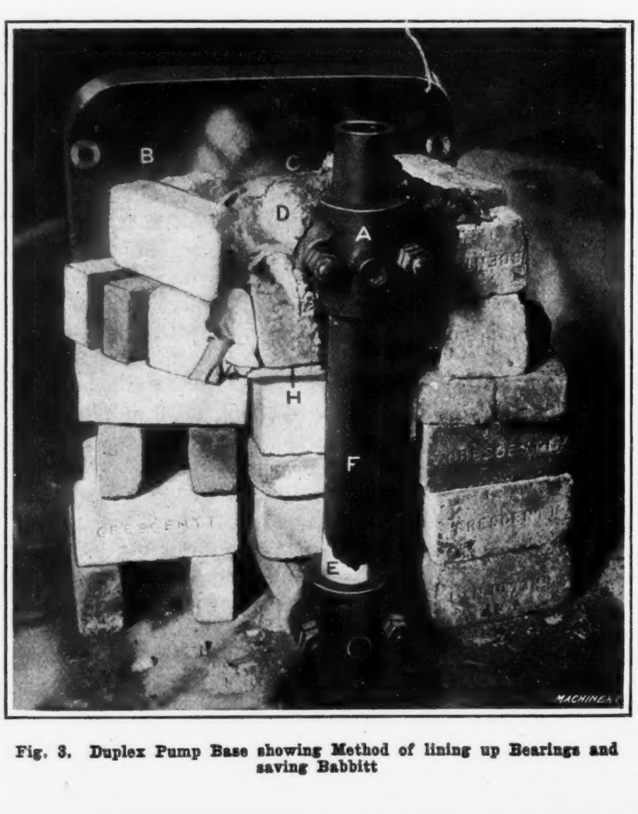


Fig. 3. Duplex Pump Base showing Method of lining up Bearings and saving Babbitt

conditions will show that a careful man can save far more in the cost of gases than any wages which he is paid. Oxygen costs on the average, say, 2½ cents per cubic foot, and a medium size tip uses 25 to 30 feet per hour, so that the oxygen expense runs from 60 to 75 cents per hour. The cost of acetylene will run, depending upon how it is made, from 20 to 50 cents per hour; the total is from $1 to possibly $1.25 per hour. It can be readily seen, therefore, that carelessness or slow speed on the part of the welder is very expensive, and that it is advisable to get good men and pay them good wages.

In repair work no consideration should be given to piecework or bonus systems of paying the men. The writer has had a great deal of experience with piecework, and under certain conditions, if properly handled, it is an admirable method of increasing earnings by stimulating men to eliminate lost time and useless work; but in repair work it is impossible to set any piecework price that will be fair to both the workmen and the employer, and for this reason no attempt should be made to use it. A good welder of the proper temperament who is paid good wages, will do good work, and this is the most important thing in welding, being far more essential than mere speed. Again, repair work is an art; and a self-respecting welder will not permit himself to be hurried beyond the rate which he considers essential to good work. At the same time, he will not permit himself to loaf; and a man who is so constituted that he will allow himself to do poor or slow work deliberately has no place in a repair shop.

Rest Periods Required on Large Work

One of the objections raised by the workmen is the tremendous amount of heat given off by large pieces in a hot fire. A man cannot do good work unless properly protected, and in some cases it is impossible even with the best protection that can be afforded for a man to stand the heat more than fifteen to twenty minutes. In such cases enough extra welders should be provided so that a man will work one period and rest twice as long. This is particularly necessary on large welds that require from eight to ten hours to complete. A number of cases are on record where the actual welding extended over more than twenty-four hours. It has been found that twenty minutes work and forty minutes rest for a man accustomed to such work is satisfactory; in one case, on account of the great heat, fifteen minutes work and forty-five minutes rest was found necessary. It is not advisable in moderately heavy welding to have a man stay at the work more than two hours at a time.

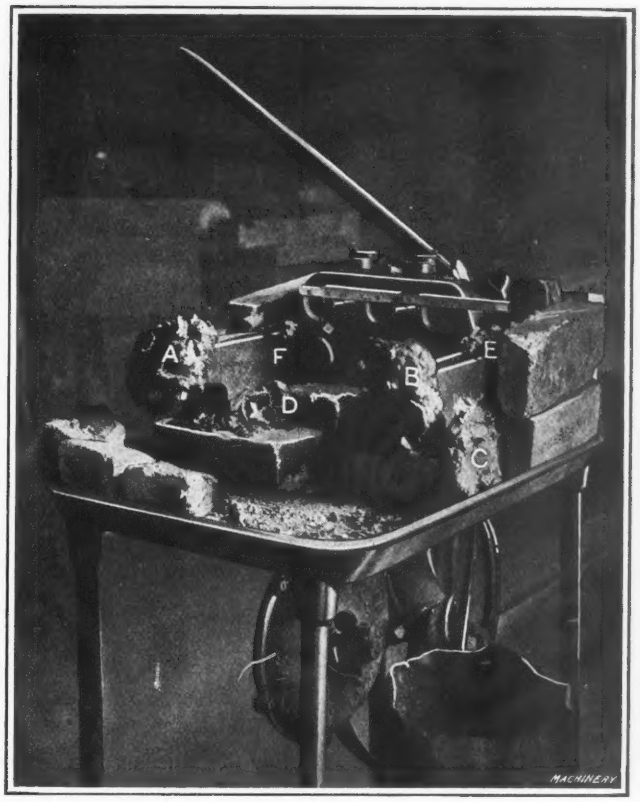


Fig. 5. Pump Body showing Method of saving Babbitted Bearings

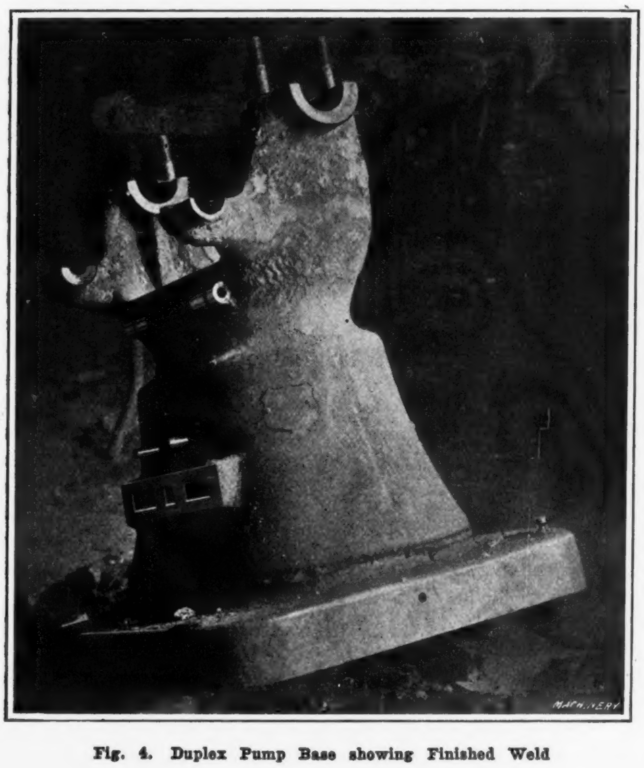


Fig. 4. Duplex Pump Base showing Finished Weld

In heavy welding, the torch tips, if made of brass, are likely to become overheated, unless great care is taken, to such a point that the oxygen pressure will blow off the end of the tip. This can be overcome largely by keeping a pail of water nearby in which the end of the tip can be dipped when necessary. It is bad practice to dip the whole head of the torch, as this is likely to distort the end of the tip at the seat and cause a leak. The proper way is to dip the end of the tip into the water and cool it slowly. After the entire tip is cooled, the head may then be cooled, but not rapidly. This difficulty exists generally at the beginning of a deep weld where the whole head of the torch is surrounded by the hot metal. It has been found of great assistance to weld a piece of copper with the proper size hole in it onto the end of a brass tip, being sure that it is aligned carefully with the rest of the tip. This can be done by using a piece of the proper size drill rod. It will be found that this can be pulled out easily as soon as the weld is finished, if care be taken not to weld the drill rod to the tip.

Care of Apparatus

Torches and apparatus are expensive and should be taken good care of. If anything is found wrong, such as leaks in the connections, they should be repaired at once, and if the tips are defective and cannot be repaired, new tips should be provided. Good results cannot be obtained with defective apparatus. The quality of the apparatus purchased should be high. The market is flooded with cheap apparatus such as torches, gages, etc., the vast majority of which are worthless. Imperfect apparatus will produce a welding flame, but will not give good results or be economical in the use of gases; also, they are frequently infringements of patents owned by manufacturers of the better apparatus, and therefore the user is liable for damages as well as the manufacturer. Only first-class apparatus manufactured by responsible firms should be used for welding.

Strength of Welded Forgings

Sometimes trouble occurs, particularly in the case of forged steel parts, from not realizing that an oxy-acetylene weld is really only a casting, and that even with the best possible work the weld will not be as strong as the original piece. If a forged steel piece is broken by carelessness or accident, it may be possible to weld it so that it will be strong enough,

particularly if there is space enough to reinforce the weld sufficiently. On the other hand, if it has to be machined to the original size, and if the fracture is caused by the part being originally too light, the chances are that unsatisfactory results will be obtained in service. It is doubtful if any attempt should be made to weld many kinds of steel forgings. This is particularly true in the case of alloy steels, such as vanadium steel, chrome-nickel steel, etc. These materials occur usually in automobile parts, their use not being frequent in ordinary machinery.

It appears useless to weld such pieces, as they cannot be made anywhere nearly as strong as they were in the first place. Particularly objectionable is the welding of certain parts of an automobile, such as a steering knuckle, where the spindle has broken off. Many such parts have been welded and held satisfactorily, but it is not recommended and should not be done until after the customer's attention is called to the danger, and he has agreed to accept the responsibility for any damage. Even then it may be wise not to run the risk. If it is remembered that cast steel is never as strong as rolled or forged steel, it is hardly possible to go wrong in judging as to the advisability of welding. It is better to err on the side of safety than to take chances.

A further reason for being careful in welding steel is on account of the peculiar property of this metal which requires that under alternating strains a certain proportion of the elastic limit must not be exceeded, otherwise a fracture will occur in the course of time. Now the elastic limit of cast steel, no matter how good, is way below the elastic limit of forged and heat-treated steel, particularly alloy steel. Therefore a fracture will occur much sooner in the case of a weld than in the case of the original piece, even if the weld is sound. Much could be done in the way of strengthening the weld if it were possible to heat-treat it properly, but this branch has not, so far, been developed in connection with welded parts.

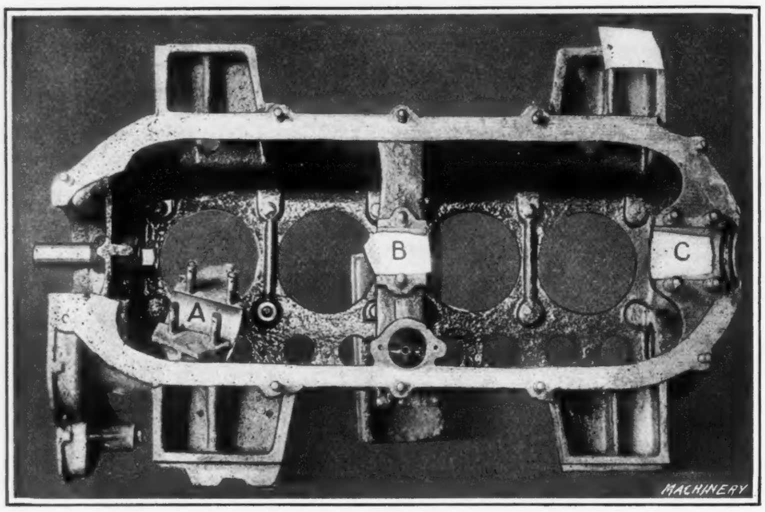


Fig. 6. Crank-case in which End Bearing is broken off

Overhead Cost

The average small shop of any kind is not usually run with the proper attention to the real cost of the work. This is particularly true in connection with welding, because it is not generally understood that there are other costs besides those of the gases and labor. Such expenses as interest, depreciation, insurance, repairs, taxes, advertising, soliciting, etc., have to be paid out of the earnings of the shop, although they are generally not taken into account in the proper way. A large concern with competent accountants does take care of these things, and realizes that its customers have to pay for them in the price of the work. Many small welding shops have lost out by not paying attention to these matters. Again, the cost of gases is frequently taken at the invoice price without considering freight and cartage which have to be paid both ways.

There are quite a number of other items that have to be taken into account in order to be sure that the proper cost of the work is obtained. Let us assume some figures, which, while not exact, will not be far out of the way for a moderate size repair shop. Let us assume that the plant cost $1000, and that the fixed charges will be as follows: Interest 6 per cent, depreciation 10 per cent, repairs 5 per cent, insurance 2 per cent, taxes 1 per cent—a total of 24 per cent or $240 per year. The operating expenses might be about as follows: Rent $35, heat $5, light $2, power $5—a total of $47 per month or $564 per year. There will be miscellaneous charges, depending on the work done, for welding rods, hand tools, such as files, chisels, hacksaw blades, etc., charcoal, cartage, and some other things, which will run up to, let us say, $25 per month or $300 per year. If the welder is an all-around man, his labor will be worth at least forty cents an hour. A competent solicitor will cost at least $75 per month or $900 per year. The total of these charges, exclusive of the welder's labor, amounts to $2000 per year. If oxygen is bought in 500 cubic foot lots and costs two cents a cubic foot, freight and cartage on it will probably cost $3 and $1, respectively, inbound. Outbound, the tanks weigh somewhat less, and we will assume that the freight and cartage amount to $3.50. This is a total of $17.50 or 3½ cents per cubic foot. If two 300-foot tanks of acetylene are procured at once, costing two cents a foot, the freight and cartage will be about the same as in the case of oxygen, or a total of $19.50 or 3.25 cents per cubic foot. If the average size tip uses 25 feet of acetylene and 30 feet of oxygen per hour, the cost of operating the torch, aside from labor, will be $1.86 per hour. To summarize: the cost per hour based on 3000 working hours per year will be as follows: overhead $0.666, labor $0.40, gases $1.86, a total of $2.926. This would be true if the assumptions are correct and if the welding were going on ten hours a day. If a welder were only occupied in welding five hours per day, the cost of gases for the daily ten hours would be 93 cents per hour, making the total cost about $2 per hour. It is evident that care must be taken to insure proper charges being made for the work, although it is to be understood that the figures given are not actual, and that they will have to be modified to suit expenses which will vary with different locations. A common charge for machine shop work is 60 to 75 cents per hour, and this is supposed to cover not only all expenses, but profit as well. The difference between these charges and those necessary to cover the cost and profit of oxy-acetylene welding are so startling that one is likely to feel that the process is very expensive. It should not be forgotten, however, that the cost per hour is not the correct basis on which to make the comparison. The results obtained should also be considered.

The above figures also indicate why in many cases it does not pay to weld inexpensive parts, and show the great necessity of employing competent welders, because it is evident that a small amount of time lost in doing a job may result in its costing more than can be charged for it; so that quick and accurate work must be done, and as little machining or finishing be required as possible, in the case of small or inexpensive pieces. There are many pieces that repair shops cannot weld profitably. For example, the sliding jaw of a vise frequently breaks off in front of the head, and while it is a perfectly possible job, and while the writer knows of no case where one has broken after welding, it being possible to reinforce it considerably, the cost of welding compared with the cost of a new part is excessive. Again, if the vise is considerably worn, as is generally the case, it is a better investment to buy a new vise, as there is no lost motion, and the condition of the jaws is good. In such cases, experience and a thorough knowledge of the real cost of welding, including overhead expenses, is necessary to determine whether it is advisable to weld the broken part. In a number of such cases policy may require the work to be done, even at a loss, for the sake of getting the larger work in the case of a good customer. Such questions have to be decided on their merits.

Difficulties with Cast-iron Welds

A difficulty that is encountered in certain cases, particularly in cast iron, is the formation of blow-holes extending from some distance down in the weld to the surface. These are generally small and in the majority of cases not important. However in gas-engine cylinder water-jackets or similar places where leaks are objectionable, they should be avoided, and in all cases care should be taken to remove them during welding. They are caused by small particles of slag or dirt, which contain in them a certain amount of air or gas. They can generally be noticed by their intensely white color. They are probably composed of silica which will not melt. All that needs to be done is to melt the metal around them and allow them to float to the surface, removing them either with the welding rod or by the use of scaling powder. A similar condition is sometimes noticed in a piece that has not been heated sufficiently; here the remedy is obvious.

There is one condition that exists frequently in cast-iron welds which has caused a great deal of trouble and rather adverse comment, and that is "hard spots." If good welding rods are used, they are the result of carelessness in welding, and generally occur at the points where the old and new metal join. It is very easy to avoid them by making the new metal at the edge of the weld a little higher than the surface of the old metal and then melting the old metal and new metal, allowing the new to run into the old. If this is properly done, there will be no hard spots at that point. It is a mistake to say that scaling powder produces hard spots. Certain kinds may make a very thin hard film on the weld, but the hard spot which gives trouble is the one first referred to. Anyone can readily test this for himself and will be convinced after two or three trials that there is a good reason for hard spots but that there is no excuse for them. Of course in some cases where no finishing is to be done except by grinding, it is not worth while to bother about hard spots, but where any machining or filing is necessary, they should be avoided. The real cause of such hard spots the writer believes to be as follows:

It will be noticed that they generally occur in comparatively thin sections, or if in thicker sections, where the metal has not been thoroughly heated; also that they generally are more frequent in fine-grained iron than in coarser metal. The action of silicon, manganese and sulphur in iron in certain proportions tends to produce an iron that will readily chill when heated and allowed to cool rapidly. The presence of large amounts of the elements favorable to producing soft iron will not, under extremely rapid cooling, make the iron soft. Now in thin sections, air cooling is sufficiently rapid, with the proper chemical composition, to produce chilled iron, and it is surprising how heavy the section may be and still chill when cooled in the air. If allowed to cool in the fire, of course, the cooling will be much slower and there will be less danger of hard spots. The action is really the formation of chilled iron, and from such tests as the writer has made, the chilling does not take place in the added metal, but occurs entirely in the original material. This is on account of the high amount of silicon in the welding rod, which is favorable to the production of soft iron. It is admitted, however, that some further tests are advisable to confirm this theory. Regardless of the theory, however, these spots can be avoided by heating uniformly and cooling slowly.

Malleable iron when heated beyond a certain point will revert to its original state of white or chilled cast iron with consequent hardness. Care should be taken not to heat the metal any more than is absolutely necessary. There is no other metal that gives any trouble from hard spots.

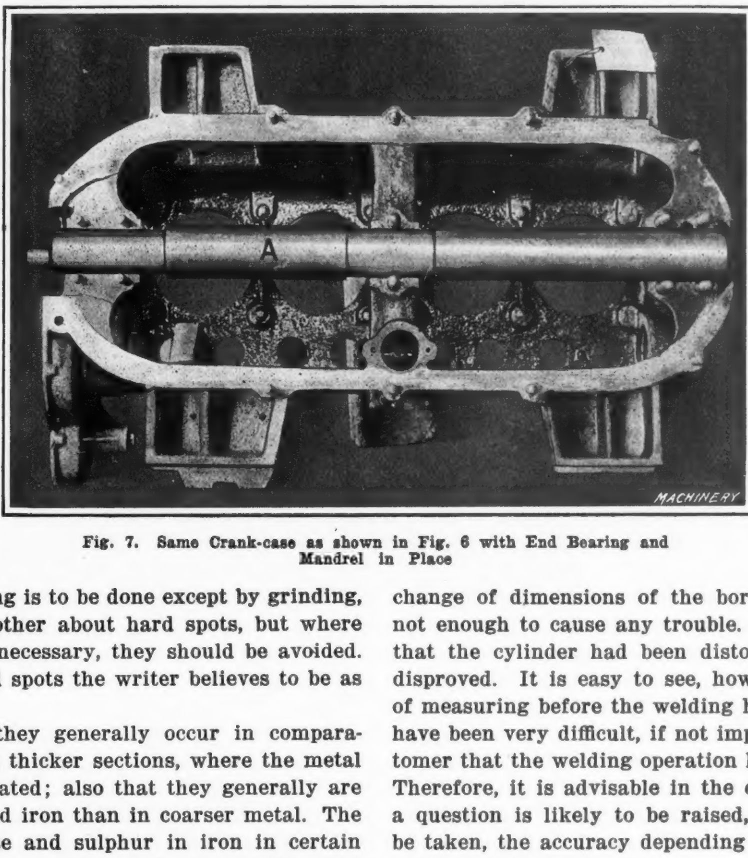


Fig. 7. Same Crank-case as shown in Fig. 6 with End Bearing and Mandrel in Place

Distortion in Welding Cylinders

Another difficulty that quite frequently arises is the claim made by a customer that the piece has been distorted by welding; for instance, an automobile cylinder in which the bore, so it is said, has been warped by heating. It is true that this does occur at times, but only in cases of very bad breaks, in the case of a certain type of cylinders where the connections between the cylinder barrel and jacket are so rigid that it requires a red heat to make the weld, or where the cylinder is carelessly overheated. There are also a number of old-style cylinders which were not annealed after rough-boring, and which warp out of shape even with the moderate heat required for jacket welding. The writer, in the beginning of his work, measured with a micrometer caliper the diameters at both top and bottom of a large number of cylinders, and with the exceptions above noted, he has yet to find any noticeable distortion of cylinders of automobile motors or gas engines. Of course there is always some difference in diameters of such cylinders after a period of service, due to natural wear. This is sometimes excessive, and will be readily detected by proper measurements before welding.

The following case, while not of this type of cylinder, illustrates the point very well. A Corliss engine 16 inches in diameter by 36 inches stroke burst out the top of the steam chest by freezing, due to the man in charge not draining it during cold weather. The cylinder was calipered at three points and gages made to suit, a maximum difference being found of 0.012 inch, due to wear. After welding and cooling, the latter requiring two days, it was found that the maximum change of dimensions of the bore was less than 0.003 inch, not enough to cause any trouble. The claim of the customer that the cylinder had been distorted was, therefore, readily disproved. It is easy to see, however, that if the precaution of measuring before the welding had not been taken, it would have been very difficult, if not impossible, to convince the customer that the welding operation had not injured his cylinder. Therefore, it is advisable in the case of any job about which a question is likely to be raised, that careful measurements be taken, the accuracy depending on conditions, and a record kept for future reference.

Expansion and Contraction

One of the greatest difficulties to be contended with is the control of expansion and contraction due to differences in temperature of different parts of the piece welded. Cast iron, being comparatively brittle, is peculiarly subject to cracks caused by temperature strains, but all other metals have also such strains in them, and while they may not crack, they change their shape if care is not taken to handle them properly.

There is no general rule for taking care of expansion and contraction strains. It must be remembered that they are always present, and experience will show in what way they will manifest themselves. Sometimes they can be avoided by setting the pieces so as to allow the shrinkage to bring the parts to their original shape, but considerable thought and ingenuity has to be exercised at times to take care of it. Sometimes a sound weld can be made, but the strains will have been distributed through the piece, distorting it and requiring

the addition of extra metal to some of the finished surfaces so that they may be machined to their original dimensions.

Fig. 2 is introduced to show the principle of taking care of contraction. It will be noticed that this piece has been welded before and that it did not break in the weld. It really is not strong enough for the work to which it is subjected. Before taking the photograph, the crack was wedged apart to show it more distinctly. A little thought will show that if breaks *A* and *B* are welded at different times, it will be hard to avoid shrinkage strains, as the distance between the two welds is very short, not over 3 inches. If, however, they can be welded at the same time, this difficulty will be overcome, as the shrinkage will be uniform. It will also be seen that if the crack is opened to allow for contraction, the pieces will not separate parallel to each other, but will swing around the point *C* as a center, causing strain at that point.

The method followed, therefore, was to heat the bar *D* with a gas flame sufficiently to open the crack the desired amount. Two welders, one working on each crack, finished the welds at the same time. A heavier tip was used on crack *B* than on crack *A*, as the section was heavier and larger. It might be stated that the old welds shown were made over a year before the piece broke the second time.

Fig. 1 is shown to indicate one method of partly overcoming shrinkage strains that would ordinarily occur. The break does not extend to the bottom flange of the crank-case. The part broken out was in four small pieces when received, and in welding them in, the edges were welded first, leaving the section *B* about 1/16 inch higher than its original location. Before welding, a little metal was added to the edges of the holes *A* in the piece, to provide for the elevation above described, so that the holes could be finished to their original size. The bridge between the holes was welded first, then the sides, and after that the center. While this will not entirely remove the shrinkage strains, it gives a certain opportunity for shrinkage to occur without causing trouble. In this instance, the metal was of good quality and no trouble whatever was experienced. This method can also be followed at times in welding badly frozen cylinder water-jackets. Of course it does not make as good looking a job as if the surfaces were left in their original location, but if possible to do it, it saves trouble.

A method used for saving the babbitt bearings, and also for the purpose of lining up the bearing that was broken off as shown in Fig. 4, is indicated in Fig. 3. A piece of 3-inch seamless tubing was clamped in the bottom bearing, using a piece of asbestos paper *E* to raise it slightly above its original position to allow for shrinkage. Additional allowance was made by raising the bearing *A* about 1/32 inch vertically above the proper position. The bottom of the tube was plugged with wet asbestos, and it was then filled with water. Asbestos, as shown at *D*, was packed around the bearing and the fire built as usual, the sheet of tin *H* being placed to locate the bottom of the fire. The bricks below the tin are simply for the purpose of supporting the fire. The bricks above the tin surround the fire and confine it to the desired location. The break was at *C* and is more clearly shown in Fig. 4 which shows the finished job. The metal was 1½ inch thick and the break 12 inches long. When tested after cooling, it was found that the bearing was in alignment within the thickness of a piece of paper, or about 0.003 inch. A slight scraping was all that was necessary to take care of this.

Fig. 5 shows one method of preserving babbitt bearings in cases where the part is to be heated to a high temperature. The break in this case was on the bottom of the pump body. It is evident that this had to be heated quite hot in order to compensate for shrinkage. This was done in a furnace built of firebrick, the bearings being covered at *A*, *B*, *C*, and *D* with wet asbestos, and the channels at *E* and *F* plugged with asbestos to keep the water in them from running back into the fire. These precautions, together with keeping the asbestos constantly wet and the channels filled with water, answered the purpose admirably and the bearings were not damaged.

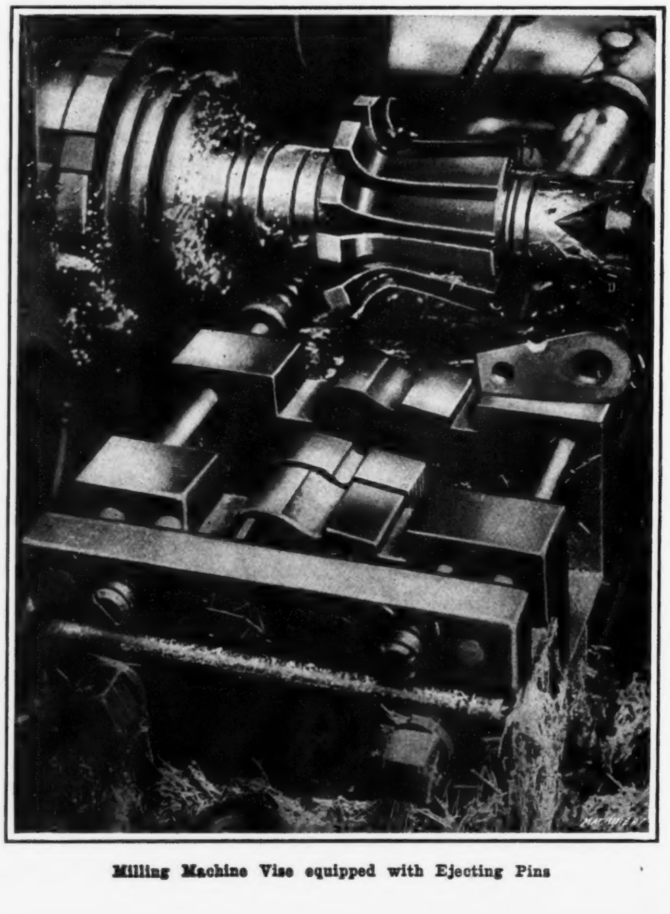
Figs. 6 and 7 show a method that can be frequently employed to replace a bearing so that it is very nearly, if not absolutely, in its original position. In Fig. 6 two pieces of cardboard, each about 0.015 inch thick, have been placed in the two sound bearings. The broken-out end bearing *A* is then put in place without the use of any cardboard, a mandrel being held in bearings *A* and *C*. Bearing *A* is held against the mandrel by means of clamps and the nuts of the bearing cap studs. It is evident that this raises the bearing *A* slightly above its original position. This compensates for the shrinkage of the weld, and in this particular case no finishing was needed except a little scraping of bearing *A*. The three bearings in this instance are of different sizes. It should also be stated that cold-rolled steel, while it is quite heavy, is, as a general rule, cheaper for mandrels than tubing. Of course, if many crank-cases of one kind are to be taken care of, it will be better to use tubing, but this material is expensive and for ordinary purposes is unnecessary.

* * *

EJECTING WORK FROM THE MILLING MACHINE VISE

At W. H. Nichols Co.'s factory in Waltham, Mass., a great deal of accurate milling of adding machine parts and similar devices is done. Many of the parts are of sheet stock, requiring edge milling and must be located by holes that have previously been punched or drilled. This means that the milling fixture must have pins over which the pieces may be located by means of the previously drilled or punched holes. After the milling cut has been taken across the work, it is often difficult to remove these pieces from the pins.

The illustration shows the method used for rapidly stripping the fixture of finished parts. Back of the stationary vise jaw is a strip of steel that carries the ejecting pins—three, in this case. These pins work through holes in the stationary vise jaw directly in back of the work. The ejecting pin bar runs on two studs that extend backward from the stationary vise jaw. The bar is operated by two rods at the ends of the bar that extend through both vise jaws. Collars on these rods are struck by the movable jaw as it opens, and thus the ejecting bar and its pins come forward and strip the work from the locating pins. Spiral springs behind the collars on the operating rods push the ejecting bar and the pins out of the way as soon as back pressure on the collars is released. The work is thus ejected squarely and with no effort other than the usual operation of the vise. C. L. L.



Milling Machine Vise equipped with Ejecting Pins

COST OF GAS CUTTING

BY J. F. SPRINGER*

Some figures are given in Table I relating to the cost of cutting steel by the oxy-hydrogen method. These figures are derived from or based on an authoritative European source. Oxygen is valued at two and one-half cents per cubic foot and hydrogen at one cent. The table may be used to show the cost where the prices of these gases differ from those here employed. The labor is taken at twenty cents an hour. Where the cost is different, the table will still furnish basic figures for a calculation by taking the change into account.

Some years ago, the writer made a calculation of the cost of cutting. It was based on data resulting from a lot of miscellaneous work. That is, there were thirty-eight cuts varying in area from 1.56 to 75.6 square inches. The average was 16.20 square inches. The oxy-acetylene method of cutting was employed. The total oxygen consumption amounted to 195 cubic feet. The average cut required, accordingly, 5.1 cubic feet of oxygen. Assuming the average cut to have been 4 inches square, we have this consumption for a lineal length of one-third foot for work 4 inches thick. Referring now to Table I, we find that 16.3 cubic feet of oxygen was required to cut one lineal foot of steel 4 inches thick. For one-third lineal foot, we get 5.4 cubic feet. There is, accordingly, pretty close harmony in the two cases; that given by the table and that derived from the thirty-eight miscellaneous cuts. Reference to Table I will show that for work thicker than one inch, the oxygen becomes a very decisive factor. It costs more per foot all the time, but for the heavier work the amount becomes rapidly greater relatively as the work increases in thickness.

The cutting of round bars is naturally a different proposition. Table II gives some practical information as to costs. As before, it is the oxy-hydrogen procedure that is used; and the labor is taken at twenty cents per hour, the oxygen at two and one-half cents per cubic foot, and the hydrogen at one cent. We find from this table that 4.8 cubic feet of oxygen is required to cut a 4-inch bar. Here the area of the cut is 12.6 square inches. Compare this with the consumption for 4-inch plate. Table I gives 16.3 cubic feet as the amount of oxygen required for a lineal foot, or 1.36 cubic foot per lineal inch. Now 12.6 square inches will be the area of the cut, when the torch has proceeded 3.15 inches. Multiplying 3.15 and 1.36, we get 4.28 cubic feet for a 4-inch cut having an area of 12.6 square inches. This is a little less than the requirement for a round cut of equal area, but the difference is not great. Hence we may formulate tentatively, the rule that it takes the same amount of oxygen to cut a given area in work of a given thickness, whatever be the form of the cross-section cut. In applying this rule, be careful to take the maximum thickness as the basis.

* Address: 618 W. 136th St., New York City.

TABLE I. COST OF CUTTING STEEL PLATE BY THE OXY-HYDROGEN PROCESS

Thickness of Plate, Inches	Time, in Minutes, consumed in Cutting 1 Foot	Labor Cost	Amount of Hydrogen, Cubic Feet	Amount of Oxygen, Cubic Feet	Cost of Gases	Total Cost
0.08	1.8	0.0060	0.5	0.5	0.0175	0.0235
0.12	1.8	0.0060	0.6	0.6	0.0210	0.0270
0.16	1.8	0.0060	0.8	0.8	0.0280	0.0340
0.20	1.8	0.0060	0.8	0.9	0.0305	0.0365
0.24	1.8	0.0060	0.9	1.1	0.0365	0.0425
0.32	1.8	0.0060	1.1	1.4	0.0460	0.0520
0.40	1.8	0.0060	1.2	1.7	0.0545	0.0605
0.48	2.2	0.0073	1.2	1.9	0.0595	0.0668
0.60	2.2	0.0073	1.3	2.4	0.0730	0.0803
0.80	2.2	0.0073	1.4	2.9	0.0865	0.0938
1.00	2.2	0.0073	1.7	3.7	0.1095	0.1168
1.20	2.2	0.0073	1.9	4.3	0.1265	0.1338
1.40	2.2	0.0073	2.1	5.2	0.1510	0.1583
1.60	2.2	0.0073	2.4	5.7	0.1665	0.1738
1.80	2.2	0.0073	2.6	6.4	0.1860	0.1933
2.00	2.2	0.0073	2.7	7.1	0.2045	0.2118
2.20	2.5	0.0083	3.0	7.9	0.2275	0.2358
2.40	2.5	0.0083	3.1	8.7	0.2485	0.2568
2.60	2.5	0.0083	3.2	9.7	0.2745	0.2828
2.80	2.5	0.0083	3.4	10.4	0.2940	0.3023
3.00	2.5	0.0083	3.5	11.4	0.3200	0.3283
3.20	2.9	0.0097	3.7	12.4	0.3470	0.3567
3.60	2.9	0.0097	3.8	14.2	0.3930	0.4017
4.00	2.9	0.0097	4.0	16.3	0.4475	0.4572
5.00	2.9	0.0097	4.1	21.8	0.5860	0.5957
6.00	2.9	0.0097	4.5	27.7	0.7375	0.7472
7.00	3.7	0.0123	4.7	33.6	0.8870	0.8993
8.00	3.7	0.0123	5.0	39.5	1.0375	1.0498
9.00	3.7	0.0123	5.4	45.5	1.1915	1.2038
10.00	3.7	0.0123	5.9	53.1	1.3865	1.3988

Machinery

TABLE II. COST OF CUTTING STEEL BARS OF CIRCULAR SECTION BY THE OXY-HYDROGEN PROCESS

Diameter, Inches	Time, Minutes	Amount of Hydrogen, Cubic Feet	Amount of Oxygen, Cubic Feet	Cost of Gas	Labor Cost	Total Cost
0.8	0.3	0.5	0.7	0.0225	0.0010	0.0235
1.6	0.4	0.6	0.7	0.0235	0.0013	0.0248
2.4	1.0	0.8	2.1	0.0605	0.0033	0.0638
4.0	1.2	1.7	4.8	0.1370	0.0040	0.1410

Machinery

We have found that our figures show a small advantage in favor of work of even thickness. This becomes more pronounced, apparently, when we take small work. Consider a round bar 1.6 inch in diameter; and plain plate 1.6 inch in thickness. A cut 1¼ inch long in the plate will have an area of 2 square inches. So also will a cut clear across the round bar. Table I shows that 1.6-inch plate requires 5.7 cubic feet of oxygen per lineal foot of cut; so that 1¼ inch will require 0.594 cubic foot. Table II shows that 0.700 cubic foot will be required for cutting through the 1.6-inch round bar. Nevertheless, the rule may be taken as a fair guide. It will be a pretty safe guide, if we calculate according to the table for round work. That work of uniform thickness should consume less oxygen than the same area of cut where the thickness varies should not surprise us. There is the same amount of steel to be cut away; but we should expect wastage with changes in thickness.

Such tables as the foregoing serve a number of purposes They give us an idea of the cost of work in advance. Again, if we are doing work covered by the tables, they enable us to determine whether our results are in accord with approved practice. Finally, such tables may prove serviceable in custom cutting, satisfying the customer as to variations in price.

A condition of all cutting is that the metal upon which the high-pressure oxygen plays shall be at a high temperature. The necessity for the flame heating the path sets a limit upon the speed of advance. Next, the amount of oxygen supplied by the cutting jet must be enough to convert the iron into magnetic oxide. Consequently, with a given cutting torch, there must be a certain pressure which corresponds with the speed determined by the heating flame, a pressure sufficient to supply the right amount of oxygen. Possibly, a certain amount of force is required to drive out the oxide. Nevertheless, there will be a pretty definite pressure corresponding to the heat capacity of the heating flame. A stronger pressure will be useless and occasion waste; a weaker pressure will require the forward speed to fall below its possibilities. Economical cutting must find the proper pressure. With a given torch, it will vary with the thickness of the work, etc. We have here an explanation, in part at least, of the greater amount of oxygen required when the thickness varies.

* * *

A new white metal alloy of high luster, capable of taking a brilliant polish and closely resembling silver in appearance, consists of 70 per cent copper, 15 per cent nickel, 9 per cent zinc, 4.3 per cent tin, and 1.7 per cent lead. The alloy is made as follows: The nickel is first melted with a flux of silica, and half of the copper is added gradually and mixed, after which the remainder of copper is added. The zinc is then quickly plunged beneath the surface of the molten metal which is stirred rapidly until the whole is melted. The lead and tin are added last while liquid. The metal is stirred and brought to a temperature of about 1700 degrees F., after which it is poured into ingot molds.

LEAD BURNING

DESCRIPTION OF APPARATUS AND METHODS USED FOR WELDING LEAD PLATES

BY JAMES F. HOBART*

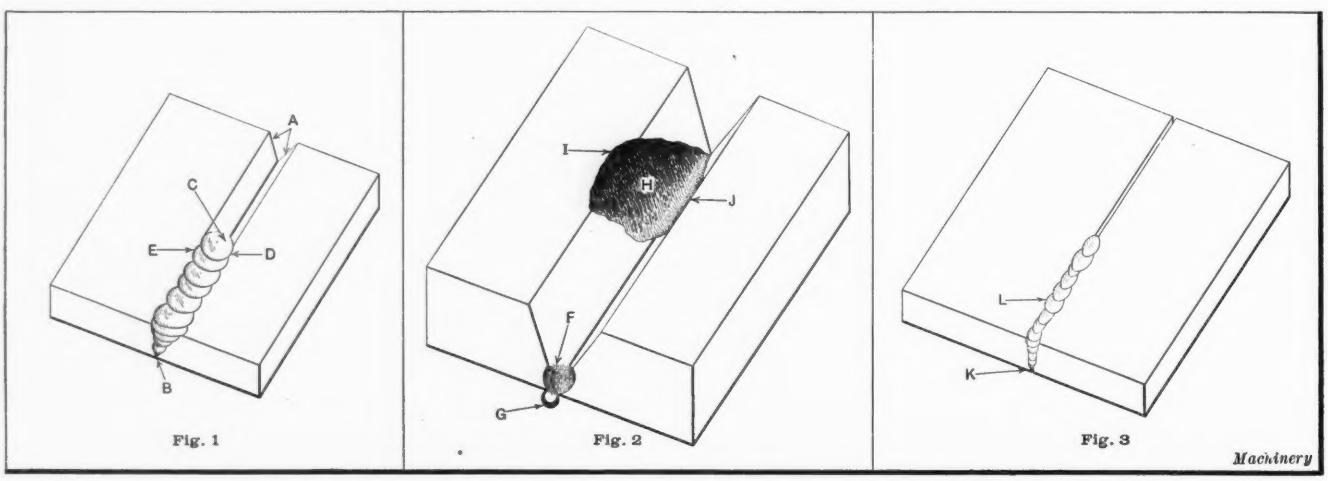
LEAD burning may be defined as a form of autogenous welding, whereby the parts to be united are joined by melting metal between them. This molten metal is obtained by heating the end of a strip of lead of the same composition as that of the lead plates to be united. The addition of metal at the joint is not actually necessary, but it serves to replace the material that was cut away before welding, and the cutting away of metal at the point of fracture is a desirable practice, as it enables the welder to work more rapidly and do better work.

The term "lead burning" is really a misnomer and should never have come into use, because the lead is not burned so long as the welder does his work properly. It would be just as proper to call the welding of iron or steel with the oxy-acetylene flame "iron burning" or "steel burning," as to call the process of welding lead by the oxy-hydrogen flame "lead burning." The operation is essentially one of welding the lead with heat furnished by the combustion of hydrogen, and the technique of the operation is almost exactly the same as that of ordinary oxy-acetylene welding. Indeed, lead burning may be effectively performed with an oxy-acetylene welding torch, and a skillful welder will soon learn the art of lead burning, using the same torch with which he welds iron or steel; but great care must be taken, because the temperature of the oxy-acetylene flame is really too high for working on lead.

However, this article is concerned with the standard method of lead burning, and for this purpose, the gases used in the torch consist of hydrogen under a pressure of from one to two pounds per square inch and air under about the same pressure. The torch in which the hydrogen is burned is designed to mix the hydrogen and air in the correct proportion, and a jet tube in the burner directs the flame against the work at the desired point. To obtain satisfactory results, the flame must have a very fine point. Fig. 1 shows the method usually employed in joining two sheets of lead, the procedure being as follows: The edges of the sheets are first beveled at *A* so that a small trough is formed with an included angle of from 24 to 30 degrees. The welder then starts at one end of this trough *B*, and the oxy-hydrogen flame is allowed to play against the edges of the work until the surfaces of the lead are softened almost to the running point.

Considerable judgment is required to determine the exact instant at which the lead is on the point of melting, and the ability to do this, hour after hour throughout the working day, can only be acquired as the result of wide experience. Just before the lead comes to the melting point, the welder brings his strip of lead or so-called "solder stick" into the flame and heats a small portion of it so that a drop of molten lead will fall into the joint at *B* at the instant that the temperature of the lead at each side of the groove has been raised to the melting point and is about to be changed to the molten condition. But at the instant that the drop of lead falls into the groove the flame is whisked to one side and the drop of molten metal breaks through the heated surface at each side of the groove, uniting with the metal in the plates. The welder carefully observes the falling of the drop of lead and its union with the metal in the plates, and if there is the least indication that all the metal has not united properly, he applies the flame at that point for a sufficient length of time to remelt the metal and allow it to flow together.

An attempt has been made at *C* to show the perfect union of a drop of lead with the metal in the plates. It will be seen that this is quite different from the well defined line between the drop of metal and plates as shown at *D* and *E*. The latter condition results when the temperatures of the drop of metal and the metal in the plates are not the same or where the temperature has not been raised sufficiently; but at *C* the temperatures were correct, with the result that the lead in the drop united with the lead in the plates in such a way that no junction line can be seen. In fact, there is no line of connection or anything that can properly be called a point, as the metal has united to form a homogeneous body. This is the condition which will be produced by a skillful lead burner.



Figs. 1 to 3. "Burning" a Joint, starting a "Burn," and Joint "burned" without beveling Plates

From *B* to *C* are shown several small globules of lead that have been melted into the joint and allowed to unite with the lead plates. It will be noted that these completely fill the groove. If all of the drops are of the same size, and are deposited in a straight line, it indicates that the work was done by a skillful lead burner; and although the beginner may secure a strong and perfect joint between the plates, it is probable that the drops of lead that he deposits in the joint will be of irregular shape and size, and will not be in a straight line.

Fig. 2 shows how a joint may be started, and also illustrates some troubles which may be experienced by a lead burner. At *F* the flame was applied to the work for too long a time with the result that some of the lead *G* has melted and run out of the joint. This must be replaced from the "solder stick" and causes a loss of both time and material. The hole shown at *H* was caused by holding the flame on one side of the joint too long with the result that the metal melted and flowed away at the point *I*. This condition will cause irregularity in the finished seam and remain as a permanent indication that the work was done by a careless or inexperienced operator.

It will be noticed that at *J* the edge of the sheet has not

* Address: 1702 Lockwood St., Indianapolis, Ind.

been melted back; it is still in line with the unwelded part of the plate and there is a probability that a leak may be found at this point when the completed joint is tested. The most skillful welders melt the edges of the plates back far enough to be sure that all the beveled edges of the metal have been heated to the melting point. It is possible to heat the edges of the plates so accurately that the metal will unite with the drops of lead without actually melting back the beveled edges; but the safer plan is to melt the lead back at each side of the joint for at least 1/32 inch, in order to be sure that a perfect union has been obtained.

Fig. 3 shows the result of attempting to burn a joint with square edged plates. This method may be employed on very thin plates but there is always a large element of doubt as to whether a perfect joint will be secured. In fact, you cannot trust a joint made with square edged plates and the chances are heavily against securing a perfect union of the metal where this plan is followed. In attempting to weld two square edged plates, the lead burner starts at end K and must melt the top edge of the plate before the lower edge can be heated. By the time that some point L is reached, other difficulties will be encountered. For one thing, he will find himself severely handicapped by having to drive the heat down through a layer of molten metal in order to heat the plates to their lower edges, and there is no way of overcoming this difficulty. The result is that there is likely to be a large part of the lower edges of the plates which has not been properly joined. But where the plates have been beveled at the edges, as previously described, the welding is done at the lower edges first, and a strong and uniform joint is secured.

The apparatus used for lead burning consists of a burner provided with two lines of rubber tubing about ¼ inch in diameter, which connect the burner with suitable sources of air and hydrogen. Rubber tubes from 50 to 75 feet long are sometimes used in order to give the welder sufficient latitude to work inside of large tanks. Metal pipes may be used for part of the distance, but it will usually be found more satisfactory to provide a sufficient length of rubber tubing to reach from the source of oxygen and hydrogen to the most remote point at which welding is to be done. The hydrogen generator should be located out of doors because it gives off noxious gases while in operation. The hydrogen may be stored in pressure tubes and delivered through a reducing valve which will maintain the pressure between one and two pounds per square inch. The air supply may be obtained by any convenient method. A hand pump can be used where power is not available, but in most cases a little motor pump will give satisfactory results. A small gasoline engine will be found satisfactory for driving the air pump if no other source of power is available.

Fig. 4 shows the arrangement of a hydrogen generator of the type used for lead burning. This is usually constructed of 1-inch boards screwed together with brass screws, as iron is quickly corroded by the acid fumes. The inside of the generator is covered with lead, and the seams between adjacent lead plates should be burned together, as the tin contained in solder would be quickly attacked by the sulphuric acid used in producing the hydrogen gas. The generating apparatus consists of two tanks located one above the other; and the vertical distance between these tanks regulates the amount of pressure on the hydrogen. The two tanks A and B are made about 8 inches wide by 8 inches high by 24 inches long and are furnished with a lead lining C. The lower tank has an inlet D fitted with a screw cap which may be removed for charging the tank with dilute sulphuric acid. A similar opening is provided at E for cleaning out the tank and removing the residual sludge which remains from the spent chemicals. The grating F is made of wood or metal bars covered with lead, and this grating supports the iron or zinc G which reacts with the sulphuric acid to generate hydrogen gas.

Valve H provides for shutting off the flow of hydrogen when the apparatus is not in use and there is a second valve at the burner that is used for the same purpose; but valve H should always be closed when it is required to shut the gas off for a considerable period of time in order to relieve the rubber tubing from strain. The arrangement of the rubber tubing and the method of connection are shown at I. A pipe J connects the upper and lower compartments of the generator, the entrance of pipe J into the upper compartment being just flush with the lead lining at L to which it is joined by burning. It will be obvious that pipe J must be made of lead and that it must also be tightly joined to the lining of the lower compartment into which the pipe projects almost to the bottom, as shown at K.

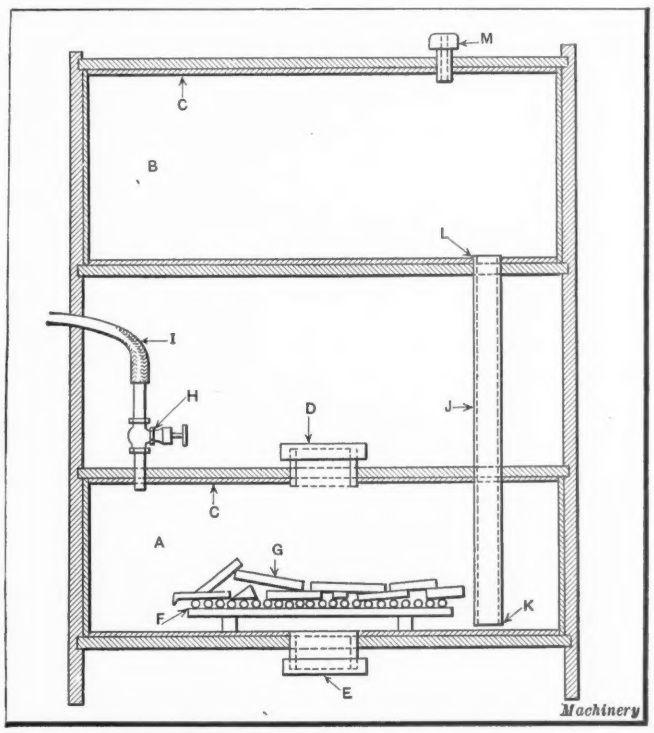


Fig. 4. Cross-sectional View of Hydrogen Generator

The method of operating the generator may be briefly described as follows: The iron or zinc G is placed in position on the grating F, and clean-out pipe E and valve H are tightly closed. Sulphuric acid diluted with water is next poured into the generator through opening D until tank A has been filled within about 2 inches of the top. The introduction of the acid should be done as rapidly as possible, after which opening D is closed immediately, as hydrogen gas is liberated the instant the acid comes into contact with the metal at G. As the gas is generated it rises through the liquid and soon fills the space at the top of tank A. Continued liberation of gas causes pressure to be set up in tank A, which results in forcing a portion of the liquid up through pipe J into upper compartment B of the generator. In case none of the gas is drawn off through valve H, more and more of the liquid will be driven up into tank B until the level of the liquid in tank A has fallen below the level of grating F, with the result that metal G is removed from contact with the acid, which causes the generation of hydrogen to be automatically stopped.

Should it happen, however, that any of the metal G falls through the grating into the bottom of tank A, generation of hydrogen will continue until the piece of metal is entirely oxidized. This continued generation of hydrogen will result in driving the liquid up through pipe J into upper compartment B until the lower end of pipe J is uncovered. This will allow hydrogen to escape through pipe J into the upper compartment of the generator, from which it escapes through vent M provided for that purpose. Vent M also provides for the escape or entrance of air as the liquid enters or leaves compartment B. In this way pressure is maintained upon the hydrogen gas, the amount of pressure being determined by the difference of level of the liquid in compartments A and B of the generator. The arrangement is such that the pressure is usually a little over one pound per square inch. When all of the liquid is forced up into compartment B, the pressure will naturally be somewhat higher than it is when most of the liquid is in compartment A, but the maximum variation is not

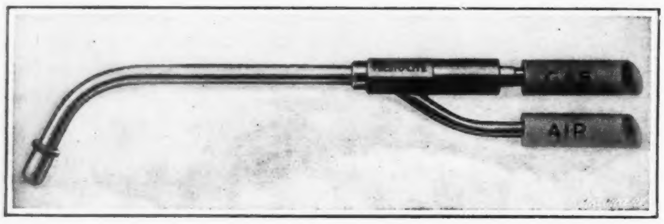


Fig. 5. Modern Lead Burning Torch which uses Acetylene and Air

more than eight or nine ounces and exerts little effect upon the action of the flame at the welding point.

When hydrogen gas is drawn off from tank *A*, especially if it is drawn off faster than the gas is being generated, liquid flows down through pipe *J* into the lower compartment *A*, so that the action of the generator is entirely automatic as long as the supply of metal *G* and dilute sulphuric acid lasts. Vent tube *M* may be closed with a pipe cap through which several small holes have been drilled, to prevent large pieces of dirt and insects from finding their way into the tanks.

Since the development of the method of generating acetylene by the chemical reaction of calcium carbide and water, the apparatus used for lead burning has been materially simplified by the substitution of acetylene gas for hydrogen. In the most modern lead burning outfits, the blower or pump for supplying the necessary amount of air has also been dispensed with and a tank of compressed air is substituted, which has a suitable reducing valve to regulate the pressure. Figs. 5 and 6 illustrate a modern lead burning torch and a complete lead burning outfit, respectively, these equipments being of the type manufactured by the Prest-O-Lite Co. of Indianapolis, Ind. Fig. 6 shows a regular oxy-acetylene welding outfit provided with a bench regulating block, acetylene and oxygen tanks, and suitable reducing valves. To change this outfit for use in lead burning, the oxygen cylinder is replaced by a tube of compressed air or the torch may be supplied with air by any convenient method. The ordinary welding torch may be used, or a more simple torch may be employed. Fig. 5 shows a torch of simple design, especially intended for use in lead burning operations; it is not provided with the adjusting valve required on the oxy-acetylene torch, and the combustion of acetylene is effected by supplying air to the torch in place of pure oxygen. This reduces the intensity of the temperature of the flame to such a degree that it is suitable for melting lead without causing excessive oxidation or danger of melting the metal too rapidly.

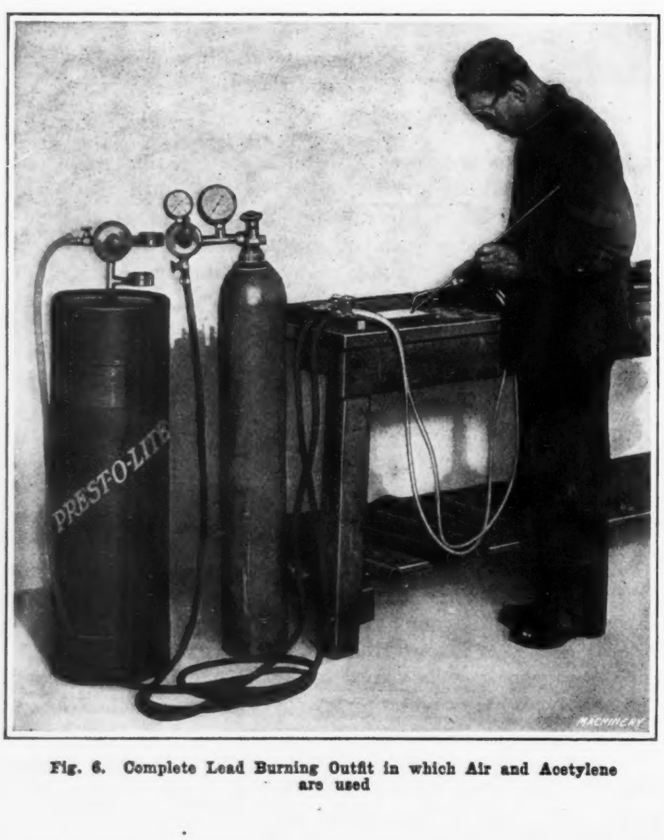


Fig. 6. Complete Lead Burning Outfit in which Air and Acetylene are used

DESIGN OF BACK-GEARS

BY M. R. BOWERMAN*

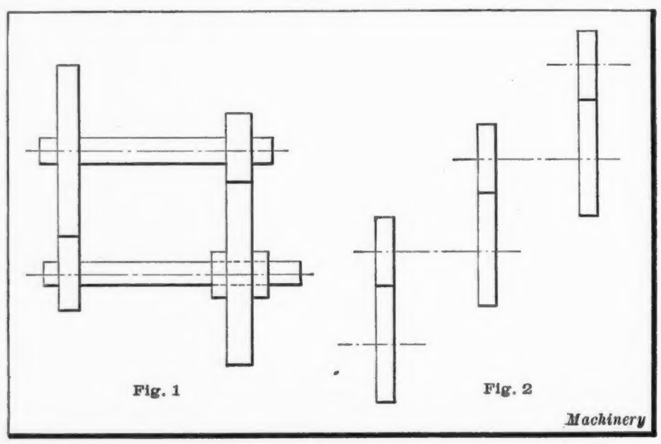
The following method will be found useful for determining the number of teeth in each of the gears of a back-geared train, or in any other train of gears where the center distance is the same for each pair of wheels. The method is based on the assumption that the pitch of the teeth is the same for all pairs of gears. Suppose it is desired to determine the number of teeth for each of the gears in a set of back-gears which are to have a ratio of $\frac{1}{N}$. The familiar arrangement of a set of back-gears is shown diagrammatically in Fig. 1, and to determine the number of teeth for the wheels, the required ratio $\frac{1}{N}$ is factored into two equivalent ratios as follows:

$$\frac{1}{N} = \frac{1}{O} \times \frac{1}{P}$$

The sum of the number of teeth in either pair of wheels is given by the following formula:

Number of teeth $= K\,(O + 1) \times (P + 1)$.

The value of the factor K is such that for the smallest sizes



Figs. 1 and 2. Back-geared and Triple-geared Drives with Constant Center Distance

of gears which can be used, it will reduce the product $(O + 1) \times (P + 1)$ to a whole number. There will, of course, frequently be a minimum limit to the size of the smallest gear which will call for the use of a higher value of K than that which is actually required to reduce the preceding product to an integral number.

The use of this method will be better understood by illustrating its application in an actual problem of gear design. *Example 1:* Suppose it is required to design a set of back-gears which have a ratio of $\frac{1}{56}$. Factoring this ratio, we obtain $\frac{1}{56} = \frac{1}{7} \times \frac{1}{8}$. The sum of the number of teeth in either pair of gears is $1\ (7 + 1) \times (8 + 1) = 72$. $\frac{72}{7+1} = 9 =$ number of teeth in one pinion. The number of teeth in the mate for this pinion is $72 - 9 = 63$. $\frac{72}{8+1} = 8 =$ number of teeth in the other pinion. The number of teeth in the mate for this pinion is $72 - 8 = 64$. As a check of the accuracy of this solution, the following proof may be employed: $9 + 63 = 8 + 64 = 72$, which is the sum of the number of teeth in each pair of gears; and $\frac{9}{63} \times \frac{8}{64} = \frac{1}{56}$, which is the required ratio for the back-gear.

The following explains the use of the method in a case where it is necessary to employ a fractional value for the factor K in order to obtain an integral value for the sum of the

* Address: Department of Applied Mechanics and Machine Design, Kansas State Agricultural College, Manhattan, Kan.

number of teeth in either pair of gears:

Example 2: Suppose the required ratio of gears is $\frac{1}{17}$. To factor this fraction, it is necessary to multiply and divide by some number, say 5; and using $2\frac{1}{2}$ as the value of K, the sum of the number of teeth in each pair of gears is found to be:

$$2\tfrac{1}{2}\left(\frac{17}{5}+1\right)\times(5+1)=\frac{5}{2}\times\frac{22}{5}\times 6=66.\quad \frac{66}{\frac{22}{5}}=15=$$

number of teeth in one pinion. The number of teeth in the mate of this pinion is $66-15=51$. $\frac{66}{6}=11=$ number of teeth in the other pinion; and $66-11=55=$ number of teeth in the mate of this pinion. As a check on the accuracy of the result, we have $15+51=11+55=66$; and $\frac{15}{51}\times\frac{11}{55}=\frac{1}{17}$, which is the required ratio.

The same method may be employed in determining the numbers of teeth in the gears of a train composed of any number of pairs of wheels, provided the center distances are the same for all pairs of wheels. Such a condition is shown in Fig. 2 for a train composed of three pairs of gears, and the following example explains the use of the method in determining the numbers of teeth in each of the wheels in the transmission shown in this illustration:

Example 3: Suppose the required ratio of train is $\frac{1}{79}$. To factor, we multiply and divide by 16 and obtain $\frac{1}{4}\times\frac{1}{4}\times\frac{16}{79}$.

Using the value of $\frac{16}{25}$ for the value of factor K, the sum of the numbers of teeth in each pair of wheels is found to be $\frac{16}{25}(4+1)\,(4+1)\left(\frac{79}{16}+1\right)=95$. Then following the method of procedure already explained in Example 2, we find the following values for the three pairs of gears which compose the train: $\frac{19}{76}$, $\frac{19}{76}$ and $\frac{16}{79}$.

In case gears of different pitches are to be used for the different pairs of wheels in a train, the numbers of teeth may be calculated by the above method by first assuming the same pitch for all of the gears in the train. For the required pitch, the number of teeth in each pair of wheels is then obtained by multiplying the previously determined value of the number of teeth by the ratio of the assumed diametral pitch to the diametral pitch which it is required to employ.

* * *

PRACTICAL APPLICATION OF THE METRIC SYSTEM

During the past year the metric system of measurement has been used to a much greater extent than formerly in the United States, due to the manufacture of munitions of war for European nations employing this system. For this reason it may be of value to give a few of the principal facts relating to the application of the metric system in practical shop and drafting-room work. In doing so, we are concerned primarily with the metric system of length measurements, as this is the only part of the system with which the draftsman and machinist come into direct contact.

The United States by an Act of Congress in 1866 legalized the metric system of weights and measures in this country, and it is one of the most peculiar paradoxes that the metric system is the only one that is legalized by Congress for use in this country. In legalizing the system, Congress decided that one meter is equal to 39.37 inches. There is a slight discrepancy between this value and that considered as the Imperial British standard, which according to the *Encyclopaedia Brittanica*, Volume XXVIII, page 489, makes one meter equal to 39.370113 inches. For ordinary practical work, however, this difference is not great enough to be of any importance. Nevertheless, it is a peculiar state of affairs that Congress decided upon an equivalent for the meter different from that recognized by the rest of the world.

The length units of the metric system that are most generally used in connection with any work relating to mechanical engineering are the meter (39.37 inches), the centimeter (0.3937 inch), and the millimeter (0.03937 inch). One meter equals 100 centimeters or 1000 millimeters. The decimeter is not commonly used as a length measurement. On mechanical drawings all dimensions are generally given in millimeters, no matter how large they may be. In fact, dimensions of such machines as locomotives and large electrical apparatus are given exclusively in millimeters. This practice is adopted to avoid mistakes due to misplacing decimal points, or misreading dimensions if other units are used as well. When dimensions are given in millimeters, the majority can be given without resorting to decimal points, as a millimeter is only a trifle more than 1/32 inch. Only dimensions of precision need be given in decimals of a millimeter; such dimensions are generally given in hundredths of a millimeter—for example, 0.02 millimeter, which is equal to 0.0008 inch. As 0.01 millimeter is equal to 0.0004 inch, it is seldom that dimensions would be given with greater accuracy than to hundredths of a millimeter.

Drawings made to the metric system are not made to scales of ½, ¼, ⅛, etc., as in the case of drawings made to the English system. If the object cannot be drawn full size, it is generally drawn one-fifth size, and, if this is too large, it is drawn one-tenth size. In exceptional cases, when very large objects are to be shown on a drawing, scales of one-twentieth, one-fiftieth, and one-one-hundredth may be used.

Small tools, such as taps, dies, drills, reamers, etc., are made to the metric system by practically all the small tool manufacturers in the United States. There are two standard systems for screw threads based on metric measurements, known, respectively, as the French and the International systems. Tables giving diameters and pitches and all other necessary information relating to this screw thread system will be found in standard handbooks on machine shop practice (see MACHINERY'S HANDBOOK, pages 1018 to 1020, inclusive). Lists of drills made to the metric system are given in the catalogues of the drill manufacturers. Reamers are also obtainable in metric measurements from the makers of these tools. The standard taper sockets generally used in the United States are frequently used in the countries employing the metric system. In Germany a movement was started a few years ago for the introduction of a metric taper shank and sockets for drills and other tools, but this standard has not been used extensively, because of the fact that so many American machine tools provided with the Morse and Brown & Sharpe taper sockets are in use in Europe.

Micrometers for measuring in millimeters are made by the leading makers of these tools in the United States. The divisions on the thimble or sleeve give hundredths of a millimeter. There is no difference in the use of a micrometer reading to the metric system and one reading to the English inch system, provided this value of the graduations is kept in mind. The metric system generally should be easily grasped by American mechanics, because it is based on the same units as our monetary system. It should be just as easy to figure in millimeters and hundredths of a millimeter as to figure in dollars and cents.

* * *

At a colliery in Rutherglen, Scotland, there was, until recently, an old "atmospheric" engine in use. The engine had been at work at the colliery for hoisting coal since it was erected in 1809. During that time, no part had been renewed, with the exception of two spur gears which were broken by accident. The engine was superseded by one of modern construction a few months ago, and was then the oldest engine in use in Scotland, and the only one of the "atmospheric" type in use in Great Britain. The engine was offered to the city of Glasgow with the understanding that it would be placed in one of the parks, and it now constitutes one of the interesting sights in Kelvingrove Park, Glasgow.

WOODRUFF KEYS AND KEYWAYS

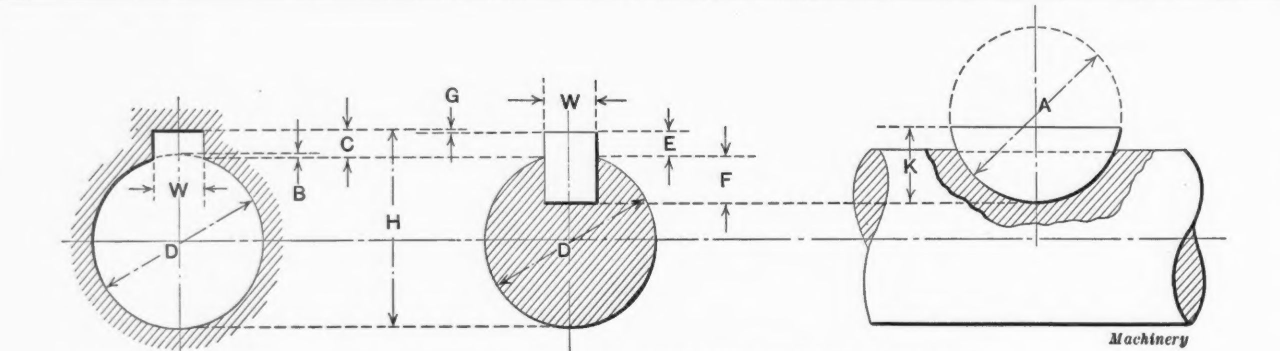
The efficient way of managing a manufacturing plant is to furnish from the designing department or drafting-room all data required for producing a part, leaving nothing to be decided by the operator or foreman that can be simply and clearly expressed on a blueprint. The Frost Gear & Forge Co., Jackson, Mich., issues blueprints of Woodruff keys and keyways to its workmen carrying the data that is reproduced in Tables I and II.

It will be noted that in Table I the dimensions have been computed and tabulated for keys and keyways suitable for shaft diameters from 1/2 to 2 inches diameter, inclusive. The clearance G between the top of the key and the keyway is 0.005 inch for all shafts up to one inch diameter, and 0.008 inch for all shafts of one inch to two inches diameter. These clearances are allowed for in the table. The depths E and F are given for the various sizes of keys as applied to shafts of varying diameters, and also the distance B between the tangent and the corner of the shaft next to the key. Hence when sinking a keyway, the proper depth can be measured with a micrometer on the lifting screw, starting with the cutter tangent to the shaft. The data in Table I is given in separate columns for keys Nos. 2 and 4; 3, 5, and 7; etc.

Now, for example, what are the essential data for the key and keyseat in a one-inch shaft and hub, the key being a No. 5? The diameter of cutter A is 5/8 inch; the width W of key, 1/8 inch; height E from corner of shaft to top, 1/16 or 0.0625 inch; depth F 0.188 inch; total height K of key, 1/4 inch; height B from corner of shaft to tangent, 0.0039 inch; depth C of keyway in hub from corner, 0.071 inch; total dimension H in hub from bottom of keyway to opposite wall of bore, 1.0671 inch. In this case of a one-inch shaft the clearance G is 0.008 inch. Hence the dimension H is composed as follows: $E + G - B + D + 0.0005$ (tolerance of shaft in hub), or $0.0625 + 0.008 - 0.0039 + 1.0000 + 0.0005 = 1.0671$ inch.

Table II gives the dimensions of cutters from Nos. 1 to 36, inclusive of those designated by the letters A, B, C, D, E, F, G, R, S, T, U, and V. Both tables are excellent examples of the kind of data that should be furnished by the designing department of the modern plant. Nothing is left to guesswork or inference; every essential dimension is given in plain figures so that the workman has no excuse for making mistakes.

TABLE I. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS



KEYWAY IN HOLE

KEY AND KEYSEAT IN SHAFT

Clearance G=0.005" for holes up to 1" diameter
Clearance G=0.008" for holes from 1" to 2" diameter

Allowance is made in table for clearance G

Diameter of Shaft	No. of Key	W = 3/32, E = 3/64			No. of Key	W = 1/8, E = 1/16			No. of Key	W = 5/32, E = 5/64			No. of Key	W = 3/16, E = 3/32			No. of Key	W = 7/32, E = 7/64		
		A	F	K		A	F	K		A	F	K		A	F	K		A	F	K
	2	1/2	0.156	13/64	3	1/2	0.141	13/64	6	5/8	0.172	1/4	9	3/4	0.219	5/16	12	7/8	0.266	3/8
	4	5/8	0.203	1/4	5	5/8	0.188	1/4	8	3/4	0.234	5/16	11	7/8	0.281	3/8	14	1	0.328	7/16
	.	.	.....	..	7	3/4	0.250	5/16	10	7/8	0.297	3/8	13	1	0.344	7/16	17	1 1/8	0.375	31/64
	.	.	.....	..	.	.	.....	..	..	.	.....	..	16	1 1/8	0.391	31/64	20	1 1/4	0.438	35/64
	.	.	.....	..	.	.	.....	..	..	.	.....	..	19	1 1/4	0.453	35/64	..	.	.....	..
	.	.	.....	..	.	.	.....	..	..	.	.....	..	26	2 1/8	0.438	17/32	..	..	.....	..

D	B	C	H	B	C	H	B	C	H	B	C	H	B	C	H
1/2	0.0044	0.052	0.5476	0.0079	0.068	0.5601	0.0125	0.083	0.5705	0.0183	0.099	0.5807	0.0252	0.114	0.5888
9/16	0.0039	0.052	0.6106	0.0070	0.068	0.6235	0.0111	0.083	0.6344	0.0161	0.099	0.6454	0.0221	0.114	0.6544
5/8	0.0035	0.052	0.6735	0.0063	0.068	0.6867	0.0100	0.083	0.6980	0.0144	0.099	0.7096	0.0198	0.114	0.7192
11/16	0.0032	0.052	0.7363	0.0057	0.068	0.7498	0.0090	0.083	0.7615	0.0130	0.099	0.7735	0.0179	0.114	0.7836
3/4	0.0030	0.052	0.7990	0.0052	0.068	0.8128	0.0082	0.083	0.8248	0.0119	0.099	0.8371	0.0163	0.114	0.8477
13/16	0.0028	0.052	0.8617	0.0048	0.068	0.8757	0.0076	0.083	0.8879	0.0110	0.099	0.9005	0.0150	0.114	0.9115
7/8	0.0025	0.052	0.9245	0.0045	0.068	0.9385	0.0070	0.083	0.9510	0.0100	0.099	0.9640	0.0139	0.114	0.9751
15/16	0.0024	0.052	0.9871	0.0042	0.068	1.0013	0.0065	0.083	1.0140	0.0094	0.099	1.0271	0.0129	0.114	1.0386
1	0.0022	0.055	1.0528	0.0039	0.071	1.0671	0.0061	0.086	1.0799	0.0089	0.102	1.0931	0.0121	0.117	1.1049
1 1/16	0.0021	0.055	1.1154	0.0037	0.071	1.1298	0.0058	0.086	1.1427	0.0083	0.102	1.1562	0.0114	0.117	1.1681
1 1/8	0.0020	0.055	1.1780	0.0035	0.071	1.1925	0.0055	0.086	1.2055	0.0080	0.102	1.2190	0.0107	0.117	1.2313
1 3/16	0.0018	0.055	1.2406	0.0033	0.071	1.2552	0.0051	0.086	1.2684	0.0075	0.102	1.2820	0.0102	0.117	1.2943
1 1/4	0.0017	0.055	1.3033	0.0031	0.071	1.3179	0.0049	0.086	1.3311	0.0071	0.102	1.3449	0.0096	0.117	1.3574
1 5/16	0.0016	0.055	1.3658	0.0030	0.071	1.3805	0.0047	0.086	1.3938	0.0067	0.102	1.4078	0.0092	0.117	1.4203
1 3/8	0.0016	0.055	1.4284	0.0029	0.071	1.4431	0.0045	0.086	1.4565	0.0065	0.102	1.4705	0.0088	0.117	1.4832
1 7/16	0.0015	0.055	1.4909	0.0027	0.071	1.5058	0.0043	0.086	1.5192	0.0064	0.102	1.5331	0.0084	0.117	1.5461
1 1/2	0.0015	0.055	1.5535	0.0026	0.071	1.5684	0.0041	0.086	1.5819	0.0059	0.102	1.5961	0.0080	0.117	1.6090
1 9/16	0.0014	0.055	1.6161	0.0025	0.071	1.6310	0.0039	0.086	1.6446	0.0056	0.102	1.6589	0.0077	0.117	1.6718
1 5/8	0.0014	0.055	1.6886	0.0024	0.071	1.6936	0.0038	0.086	1.7072	0.0054	0.102	1.7216	0.0074	0.117	1.7346
1 11/16	0.0013	0.055	1.7412	0.0023	0.071	1.7562	0.0036	0.086	1.7699	0.0052	0.102	1.7843	0.0071	0.117	1.7974
1 3/4	0.0013	0.055	1.8037	0.0022	0.071	1.8188	0.0035	0.086	1.8325	0.0051	0.102	1.8469	0.0069	0.117	1.8601
1 13/16	0.0012	0.055	1.8663	0.0021	0.071	1.8814	0.0034	0.086	1.8951	0.0049	0.102	1.9096	0.0066	0.117	1.9229
1 7/8	0.0012	0.055	1.9288	0.0021	0.071	1.9439	0.0033	0.086	1.9577	0.0047	0.102	1.9723	0.0064	0.117	1.9856
1 15/16	0.0011	0.055	1.9914	0.0020	0.071	2.0065	0.0032	0.086	2.0203	0.0045	0.102	2.0350	0.0062	0.117	2.0483
2	0.0010	0.055	2.0540	0.0020	0.071	2.0690	0.0031	0.086	2.0829	0.0044	0.102	2.0976	0.0060	0.117	2.1110

Machinery

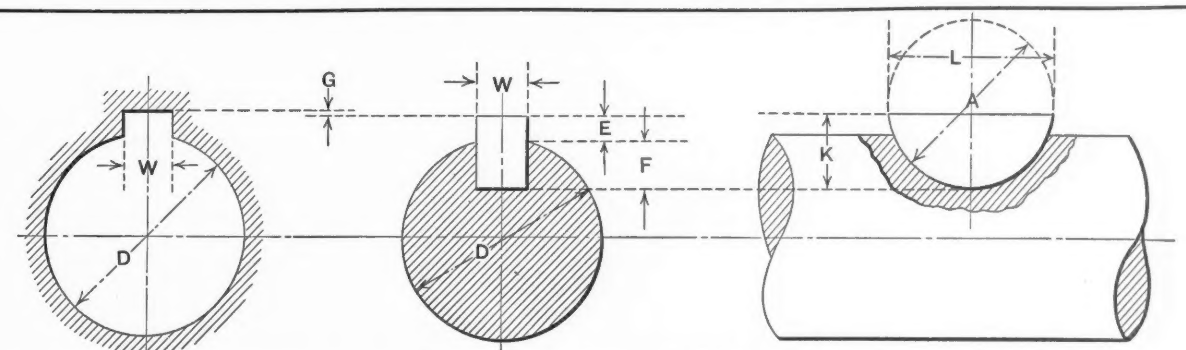
TABLE I. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS—(Continued)

Diameter of Shaft

No. of Key	W = 1/4 E = 1/8			No. of Key	W = 5/16 E = 5/32			No. of Key	W = 3/8 E = 3/16			No. of Key	W = 7/16 E = 7/32			No. of Key	W = 1/2 E = 1/4		
	A	F	K		A	F	K		A	F	K		A	F	K		A	F	K
A	7/8	0.250	3/8	..	..	.....	..	..	..	.....	..	..	..	.....	..	..	..	.....	..
15	1	0.313	7/16	B	1	0.281	7/16	E	1 1/4	0.359	35/64	U	2 3/4	0.531	3/4	V	2 3/4	0.500	3/4
18	1 1/8	0.359	31/64	C	1 1/8	0.328	31/64	F	1 3/8	0.406	19/32	31	3 1/2	0.719	15/16	32	3 1/2	0.688	15/16
21	1 1/4	0.422	35/64	D	1 1/4	0.391	35/64	G	1 1/2	0.453	41/64	..	..	.....	..	..	..	.....	..
22	1 3/8	0.469	19/32	23	1 3/8	0.438	19/32	29	2 1/8	0.344	17/32	..	..	.....	..	..	..	.....	..
24	1 1/2	0.516	41/64	25	1 1/2	0.484	41/64	T	2 3/4	0.563	3/4	..	..	.....	..	..	..	.....	..
27	2 1/8	0.406	17/32	28	2 1/8	0.375	17/32	30	3 1/2	0.750	15/16	..	..	.....	..	..	..	.....	..
R	2 3/4	0.625	3/4	S	2 3/4	0.594	3/4	..	..	.....	..	..	..	.....	..	..	..	.....	..

D	B	C	H	B	C	H	B	C	H	B	C	H	B	C	H
1/2	0.0325	0.130	0.5975	......	.....	......	......	......	......	......	......	......	......	.....	......
9/16	0.0289	0.130	0.6636	......	.....	......	......	......	......	......	......	......	......	.....	......
5/8	0.0254	0.130	0.7296	0.0413	0.161	0.7447	......	......	......	......	......	......	......	.....	......
11/16	0.0236	0.130	0.7939	0.0379	0.161	0.8106	......	......	......	......	......	......	......	.....	......
3/4	0.0220	0.130	0.8580	0.0346	0.161	0.8764	0.0511	0.1925	0.8914	......	......	......	......	.....	......
13/16	0.0198	0.130	0.9227	0.0314	0.161	0.9421	0.0465	0.1925	0.9585	......	......	......	......	.....	......
7/8	0.0177	0.130	0.9873	0.0283	0.161	1.0077	0.0420	0.1925	1.0255	0.0583	0.2237	1.0404	......	.....	......
15/16	0.0164	0.130	1.0511	0.0264	0.161	1.0721	0.0392	0.1925	1.0908	0.0544	0.2237	1.1068	......	.....	......
1	0.0152	0.133	1.1178	0.0246	0.164	1.1394	0.0365	0.1955	1.1590	0.0506	0.2267	1.1761	0.0670	0.258	1.1910
1 1/16	0.0143	0.133	1.1812	0.0228	0.164	1.2037	0.0342	0.1955	1.2238	0.0476	0.2267	1.2416	0.0625	0.258	1.2580
1 1/8	0.0136	0.133	1.2444	0.0210	0.164	1.2680	0.0319	0.1955	1.2886	0.0446	0.2267	1.3071	0.0581	0.258	1.3249
1 3/16	0.0131	0.133	1.3074	0.0204	0.164	1.3311	0.0304	0.1955	1.3526	0.0421	0.2267	1.3721	0.0551	0.258	1.3904
1 1/4	0.0127	0.133	1.3703	0.0198	0.164	1.3942	0.0290	0.1955	1.4165	0.0397	0.2267	1.4370	0.0522	0.258	1.4558
1 5/16	0.0123	0.133	1.4332	0.0191	0.164	1.4568	0.0279	0.1955	1.4801	0.0380	0.2267	1.5012	0.0499	0.258	1.5206
1 3/8	0.0120	0.133	1.4960	0.0185	0.164	1.5205	0.0268	0.1955	1.5437	0.0364	0.2267	1.5653	0.0477	0.258	1.5853
1 7/16	0.0114	0.133	1.5591	0.0174	0.161	1.5841	0.0254	0.1955	1.6076	0.0346	0.2267	1.6296	0.0453	0.258	1.6502
1 1/2	0.0110	0.133	1.6220	0.0164	0.164	1.6476	0.0240	0.1955	1.6715	0.0328	0.2267	1.6939	0.0429	0.258	1.7151
1 9/16	0.0107	0.133	1.6848	0.0158	0.164	1.7107	0.0231	0.1955	1.7349	0.0309	0.2267	1.7583	0.0412	0.258	1.7793
1 5/8	0.0105	0.133	1.7475	0.0153	0.164	1.7737	0.0221	0.1955	1.7984	0.0291	0.2267	1.8226	0.0395	0.258	1.8435
1 11/16	0.0102	0.133	1.8103	0.0147	0.164	1.8368	0.0214	0.1955	1.8616	0.0282	0.2267	1.8860	0.0383	0.258	1.9072
1 3/4	0.0099	0.133	1.8731	0.0142	0.164	1.8998	0.0207	0.1955	1.9248	0.0274	0.2267	1.9493	0.0371	0.258	1.9709
1 13/16	0.0095	0.133	1.9360	0.0136	0.164	1.9629	0.0198	0.1955	1.9882	0.0265	0.2267	2.0127	0.0355	0.258	2.0350
1 7/8	0.0093	0.133	1.9987	0.0130	0.164	2.0260	0.0190	0.1955	2.0515	0.0257	0.2267	2.0760	0.0339	0.258	2.0991
1 15/16	0.0090	0.133	2.0615	0.0127	0.164	2.0888	0.0184	0.1955	2.1146	0.0250	0.2267	2.1392	0.0328	0.258	2.1627
2	0.0088	0.133	2.1242	0.0124	0.164	2.1516	0.0179	0.1955	2.1776	0.0243	0.2267	2.2024	0.0317	0.258	2.2263

TABLE II. DIMENSIONS OF WOODRUFF KEYWAYS AND KEYS



No. of Key and Cutter	Diameter of Key	Thickness of Key	Depth in Shaft	Height Above Shaft	Height of Key	Length of Key	No. of Key and Cutter	Diameter of Key	Thickness of Key	Depth in Shaft	Height Above Shaft	Height of Key	Length of Key
	A	W	F	E	K	L		A	W	F	E	K	L
1	1/2	1/16	.172	1/32	13/64	1/2	D	1 1/4	5/16	.391	5/32	35/64	1 1/4
2	1/2	3/32	.156	3/64	13/64	1/2	E	1 1/4	3/8	.359	3/16	35/64	1 1/4
3	1/2	1/8	.141	1/16	13/64	1/2	22	1 3/8	1/4	.469	1/8	19/32	1 3/8
4	5/8	3/32	.203	3/64	1/4	5/8	23	1 3/8	5/16	.438	5/32	19/32	1 3/8
5	5/8	1/8	.188	1/16	1/4	5/8	F	1 3/8	3/8	.406	3/16	19/32	1 3/8
6	5/8	5/32	.172	5/64	1/4	5/8	24	1 1/2	1/4	.516	1/8	41/64	1 1/2
7	3/4	1/8	.250	1/16	5/16	3/4	25	1 1/2	5/16	.484	5/32	41/64	1 1/2
8	3/4	5/32	.234	5/64	5/16	3/4	G	1 1/2	3/8	.453	3/16	41/64	1 1/2
9	3/4	3/16	.219	3/32	5/16	3/4	26	2 1/8	3/16	.438	3/32	17/32	1 23/32
10	7/8	5/32	.297	5/64	3/8	7/8	27	2 1/8	1/4	.406	1/8	17/32	1 23/32
11	7/8	3/16	.281	3/32	3/8	7/8	28	2 1/8	5/16	.375	5/32	17/32	1 23/32
12	7/8	7/32	.266	7/64	3/8	7/8	29	2 1/8	3/8	.344	3/16	17/32	1 23/32
A	7/8	1/4	.250	1/8	3/8	7/8	R	2 3/4	1/4	.625	1/8	3/4	2 5/16
13	1	3/16	.344	3/32	7/16	1	S	2 3/4	5/16	.594	5/32	3/4	2 5/16
14	1	7/32	.328	7/64	7/16	1	T	2 3/4	3/8	.563	3/16	3/4	2 5/16
15	1	1/4	.313	1/8	7/16	1	U	2 3/4	7/16	.531	7/32	3/4	2 5/16
B	1	5/16	.281	5/32	7/16	1	V	2 3/4	1/2	.500	1/4	3/4	2 5/16
16	1 1/8	3/16	.391	3/32	31/64	1 1/8	30	3 1/2	3/8	.750	3/16	15/16	2 7/8
17	1 1/8	7/32	.375	7/64	31/64	1 1/8	31	3 1/2	7/16	.719	7/32	15/16	2 7/8
18	1 1/8	1/4	.359	1/8	31/64	1 1/8	32	3 1/2	1/2	.688	1/4	15/16	2 7/8
C	1 1/8	5/16	.328	5/32	31/64	1 1/8	33	3 1/2	9/16	.656	9/32	15/16	2 7/8
19	1 1/4	3/16	.453	3/32	35/64	1 1/4	34	3 1/2	5/8	.625	5/16	15/16	2 7/8
20	1 1/4	7/32	.438	7/64	35/64	1 1/4	35	3 1/2	11/16	.594	11/32	15/16	2 7/8
21	1 1/4	1/4	.422	1/8	35/64	1 1/4	36	3 1/2	3/4	.563	3/8	15/16	2 7/8

FOUR-GEAR EPICYCLIC TRAINS

BY M. TERRY*

The subject of epicyclic gearing is treated to some extent in nearly every textbook and handbook on machine design. In general, after explaining certain rules to be followed in figuring the ratios of the various forms of trains and citing a few practical applications of this type of gearing, the subject is considered exhausted. None of the books that have come to the writer's attention even hint at the incredibly large reduction ratios that are possible with a simple four-spur-gear train, consisting of two central gears, one of which is stationary, and one arm carrying two planetary gears, as shown in Fig. 2.

The nearest approach to the system about to be described can be found in the imperfect mechanism, shown in Fig. 1, described by some writers. Referring to this illustration, *B* is a wide faced pinion having 15 teeth, which meshes with both gears *C* and *D* having 30 and 29 teeth, respectively. Pinion *B* is carried by the arm *A* that is cast integral with the driving pulley which is free to turn about shaft *S*. Gear *D* is keyed to this shaft, and gear *C* is the stationary gear. As arm *A* revolves about shaft *S*, pinion *B*, being in mesh with the stationary gear *C*, is compelled to revolve about its own axis of rotation O–O. If arm *A* makes exactly one revolution, pinion *B* is compelled to engage every one of the 30 teeth on gear *C*; and in doing so, pinion *B* itself makes exactly two revolutions about O–O. At the same time, the teeth of pinion *B* come into engagement with 30 teeth on gear *D*; and as gear *D* has only 29 teeth, it is naturally compelled to move in a direction opposite to the rotation of arm *A* to make good for the difference of one tooth. Thus, for every revolution of arm *A*, gear *D* is advanced one tooth, and it will take 29 revolutions of arm *A* to produce one turn of the shaft *S*; the reduction ratio, then, of this particular train is 29 to 1. It will be observed from the preceding that for very large reduction ratios, gears *C* and *D* must have a large number of teeth. Another inherent limitation of this mechanism lies in the fact that gears *B* and *D* do not mesh on their correct pitch circles, which is productive of both noise and excessive wear, especially if the driving pulley runs at high speed.

Fig. 2 shows a four-gear epicyclic train; *D* is the stationary gear; *B* is pressed on shaft *E* which is integral with gear *C*; *A* is keyed to shaft *S*. The mechanism is encased in a housing made in the form of a hollow pulley, making a compact, dustproof and oil-tight arrangement. Shaft *E* is free to turn in its bearings, which are bored in one setting, after the two halves of the housing are doweled and fastened together by means of six screws. Gear *A* has 59 teeth, 20 pitch; gear *B* has 21 teeth, 20 pitch; gear *C* has 19 teeth, 18 pitch; and gear *D* has 53 teeth, 18 pitch.

$\frac{59 + 21}{2} \div 20 = 2$ inches = center to center distance of gears *A* and *B*.

* Address: 1003 Manning St., Flint, Mich.

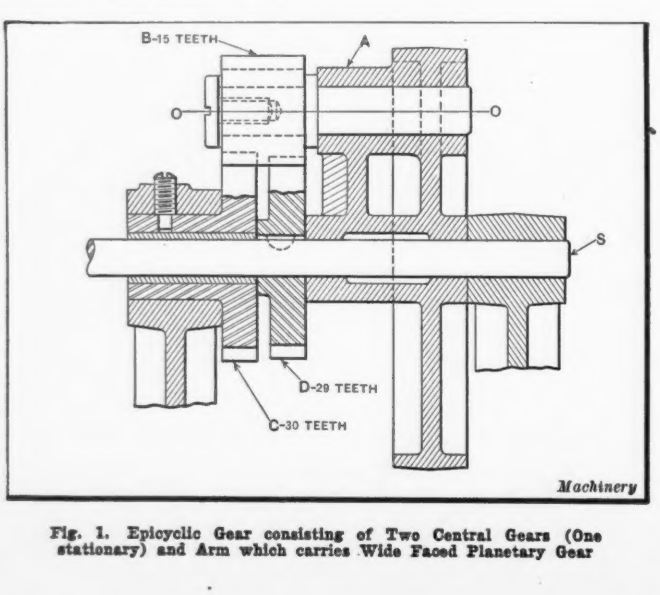


Fig. 1. Epicyclic Gear consisting of Two Central Gears (One stationary) and Arm which carries Wide Faced Planetary Gear

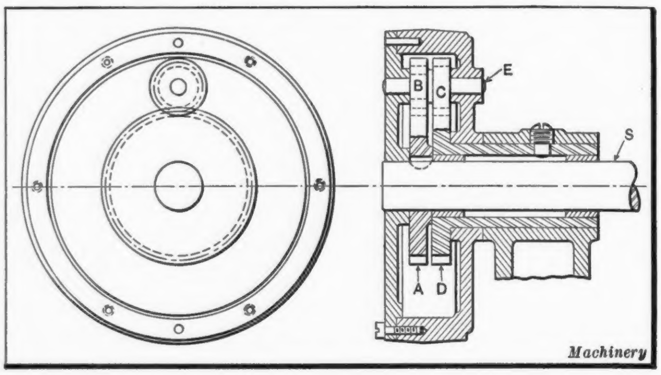


Fig. 2. Epicyclic Gear Train consisting of Two Central Gears (One of which is stationary) and an Arm which carries Two Planetary Gears

$\frac{53 + 19}{2} \div 18 = 2$ inches = center to center distance of gears *C* and *D*.

In other words, the two sets of gears are so proportioned as to insure correct engagement of their teeth. To find the ratio of this train we have: $\frac{53}{19} \times 21 = 58.58$, which is the number of teeth on gear *A* that gear *B* passes in one complete revolution of the housing. Since gear *A* has 59 teeth, it is compelled to advance the difference or $59 - 58.58 = 0.42$ tooth in the same direction as the rotation of the housing. The number of turns of the pulley that will produce one turn of shaft *S* is $\frac{59}{0.42} = 140$, and 140 to 1 is the ratio of the train.

This design is superior to the one shown in Fig. 1 for the following reasons: First, because it is mechanically perfect; and second, because high reduction ratios can be obtained with gears having comparatively few teeth. The possibility of obtaining high ratios lies in proportioning the gears, both in pitch and number of teeth, so as to compel the last of the train to advance a fraction of a tooth for one turn of the driver. Coming back to the design shown in Fig. 2, it may be stated that this mechanism has been actually built at a smaller cost than a worm and gear drive having the same ratio. The pulley housing was made about 1½ inch wide by 6 inches in diameter. To show the possibilities of this type of transmission, examples of two more trains, both of which are mechanically perfect, will be given.

First Train: *A* has 71 teeth, 14 pitch; *B* has 69 teeth, 14 pitch; *C* has 59 teeth, 12 pitch; *D* has 61 teeth, 12 pitch.

$\frac{71 + 69}{2} \div 14 = 5$ inches = distance between centers;

$\frac{59 + 61}{2} \div 12 = 5$ inches = distance between centers;

$\frac{61}{59} \times 69 = 71.34$;

$71.34 - 71 = 0.34$;

$71 \div 0.34 = 209$; and 209 to 1 is the reduction ratio.

Second Train: *A* has 63 teeth, 16 pitch; *B* has 65 teeth, 16 pitch; *C* has 61 teeth, 15 pitch; *D* has 59 teeth, 15 pitch.

$\frac{63 + 65}{2} \div 16 = 4$ inches = distance between centers;

$\frac{61 + 59}{2} \div 15 = 4$ inches = distance between centers;

$\frac{59}{61} \times 65 = 62.87$;

$63 - 62.87 = 0.13$;

$63 \div 0.13 = 484$; and 484 to 1 is the reduction ratio.

It must not be assumed that the utility of this type of train is confined to cases requiring high ratios only, for low ratios are most readily obtained.

* * *

The man who will not listen to the safety rules, may have to hear the ambulance bell.

LAYING OUT CYCLOIDAL PUMP IMPELLERS

BY GUS LUCK[*]

The graphical method of developing cycloidal pump impellers is not desirable because it is difficult to secure highly accurate results in that way. The following article describes a simple mechanical method of development which enables the work to be done rapidly and results in the production of a perfect cycloidal form. Figs. 1, 2 and 3 show two-, three-, and four-tooth impellers of 4 inches pitch diameter, that were developed with this device, and it may be mentioned in this connection that the three-tooth impeller is the one most generally used. Fig. 4 shows the generating device. In this illustration *A* is a gear of exactly the same pitch diameter as that of the impeller to be generated. This gear meshes with rack *B* and is guided by a tongue which enters the groove in plate *C*; this plate also has a T-slot located at right angles to the groove, which carries the sliding nut that supports pin *D* on which gear *A* revolves.

The 1/32-inch sheet metal plate *E* is slipped over pin *D* and held in place by a pin or screw to insure its revolving with gear *A*. Form *F*, which is the rack model of the cycloidal impeller that is to be developed, is fastened to rack *B* so that it is outside of plate *E* and so that the pitch line of form *F* exactly corresponds to the pitch line of the rack. When rack *B* is moved by the rotation of gear *A*, it will be evident that the position of form *F* is correspondingly changed. A sharp scriber or scratch-awl is used to trace the outline of form *F* on plate *E* for each slight movement of gear *A* and rack *B*, the operation being continued until one of the teeth of the impeller has been completely outlined.

Then by turning gear *A* so that plate *E* has been moved through 1/3 revolution for a three-tooth impeller, the second tooth can be laid out, after which the third tooth is outlined in the same way. A templet is thus obtained of the form shown in Fig. 2. It will be readily seen that the number of teeth in the gear should be divisible by 3 in the case of a three-tooth impeller, and experience has shown that 48 teeth of 12 pitch make a very satisfactory gear. In laying out a templet, it is sufficient to outline one of the impeller teeth for use in making the forming tool for turning the milling cutter. Fig. 6 shows a cutter for generating a three-tooth impeller of 4 inches pitch diameter.

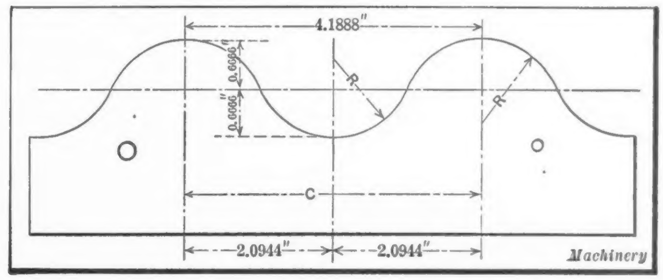
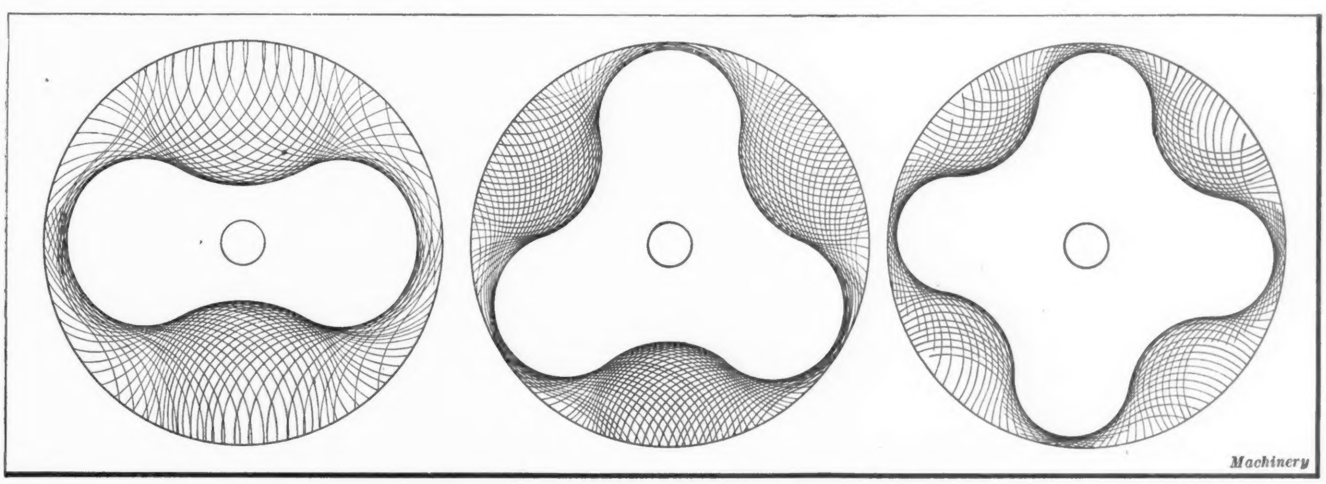


Fig. 5. Master Form for developing a Three-tooth Impeller of 4 inches Pitch Diameter

Great care should be taken to follow the outline accurately in cutting out the templet, in order to produce a templet and milling cutter that will cut an accurate impeller. It will be noticed that the addendum and dedendum are equal and that no clearance is allowed. It will, of course, be understood that the templet laid out in this way is used in making a master forming tool for turning the blank for the milling cutter with which the teeth of the cycloidal impellers are cut.



Figs. 1 to 3. Two-, Three- and Four-tooth Impeller Outlines developed by Mechanical Means

By definition, a cycloid is the curve generated by a point on the circumference of a circle when the circle is rolled on a straight line. For a generating circle 1 inch in diameter, a complete cycloid is generated when the circle rolls through a distance of 3.1416 inches along the line, *i. e.*, a distance equal to the circumference of a circle of 1 inch diameter. An epicycloid is the curve generated by a point on the circumference of a circle when rolled on the outside of a circle called the fundamental circle. Similarly, a hypo-cycloid is the curve generated by a point on the circumference of the generating circle when rolled on the inside of the fundamental circle. On cycloidal impellers, each tooth of the impeller is composed of one complete epicycloidal curve and two halves of one complete hypo-cycloidal curve. It will be seen from Figs. 1 to 3 that the addendum and the dedendum of the impeller teeth are equal, no clearance being allowed.

The following explains the method of determining the form of the templet used on the fixture for laying out the templet employed in making the master forming tool for turning the milling cutter blank. The diameter *D* of the generating circle is obtained from the following formula:

$$D = \frac{P\pi}{2\pi N} = \frac{P}{2N}$$

where P = pitch diameter of impeller;
N = number of teeth in impeller.

[*] Address: 1140 National Ave., Milwaukee, Wis.

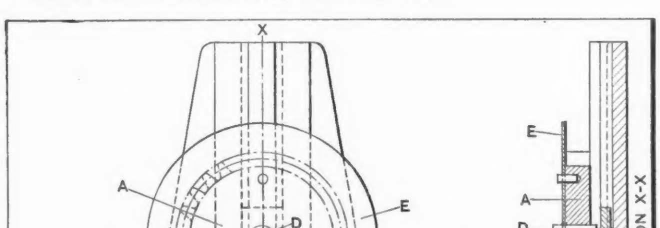


Fig. 4. Device for Use in Mechanical Development of Pump Impeller Outlines

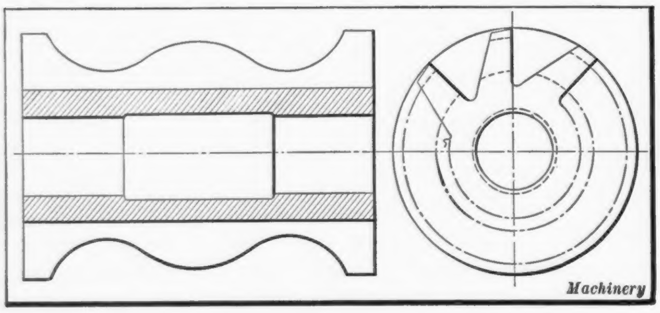


Fig. 6. Milling Cutter for producing Three-tooth Impeller of 4 inches Pitch Diameter

As it can readily be seen that the portion of the circumference of the impeller included in a distance equal to the circular pitch is made up of two halves of an epicycloid and one complete hypo-cycloid, it follows that the circular pitch of the master templet and of the impeller must be equal to twice the circumference of the generating circle, because these curves are obtained by rolling the generating circle on the outside and on the inside of arcs of the fundamental circle, which are each equal in length to the circumference of the generating circle.

The following example will assist the reader to understand the principles set forth. Suppose it is required to find the diameter of a generating circle for a three-tooth impeller of 4 inches pitch diameter:

$D = \frac{P}{2N} = \frac{4}{2 \times 3} = 0.6666$ inch = diameter of generating circle.

The outside diameter O of the impeller is:

$$O = P + 2D$$

The root diameter R of the impeller is:

$$R = P - 2D$$

The dimensions of the form for use on the fixture (Fig. 4) for laying out a templet for the milling cutter for a three-tooth cycloidal impeller of 4 inches pitch diameter are given in Fig. 5, and the following explains the method of determining these dimensions: The circular pitch must be exactly equal to the circular pitch of the impeller and the addendum and dedendum must each be equal to the diameter of the generating circle. The circular arcs of which the outline of the templet is composed are struck from the centers of the teeth and spaces, as shown in Fig. 5, and they are of such a radius of curvature that they will be tangent to the pitch line at the center of the circular pitch. The radius R of the arcs is determined by the following formula:

$$R = \frac{\left(\frac{C}{2}\right)^2 + 4\,D^2}{8\,D}$$

where C = circular pitch of impeller;

D = pitch diameter of generating circle.

Fig. 7 shows in diagrammatical form the theoretical way in which the epicycloid and hypo-cycloid curves of an impeller are obtained by rolling the generating circle on the outside and inside of the fundamental circle. This diagram is for an impeller of 4-inch pitch diameter and corresponds to the templet shown in Fig. 5. Similar diagrams for impellers of any given pitch diameter or number of teeth would be laid out with dimensions calculated according to the formulas given.

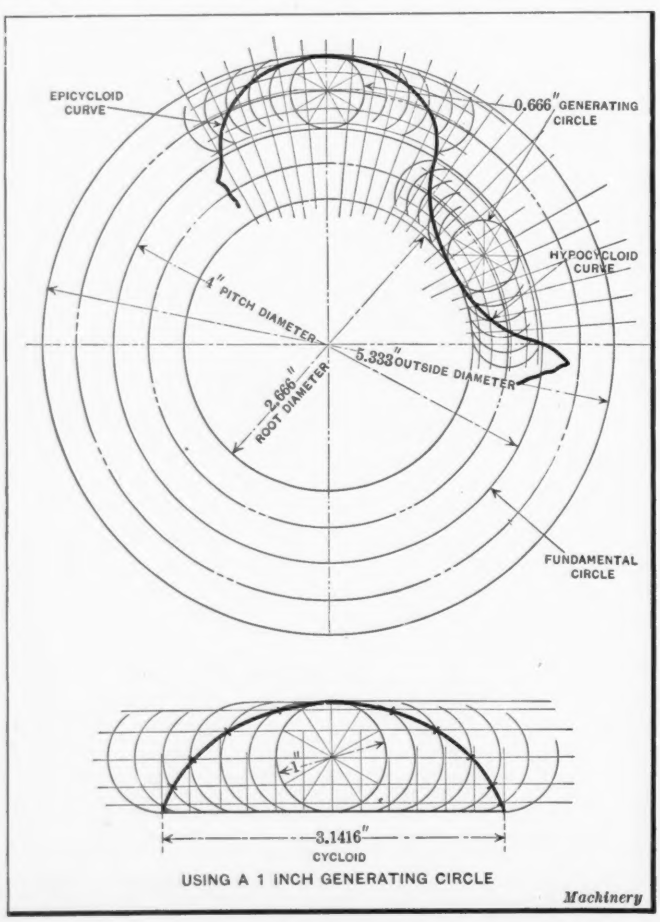


Fig. 7. Diagram showing Theoretical Method of producing Cycloid, Epicycloid and Hypo-cycloid Curves

* * *

WATCH SCREW THREADS

The accompanying table shows the number of threads per inch, the diameter of the thread, and the correct size of tap drill, for all the screws used in the watch movements made by the Waltham Watch Co., Waltham, Mass. Taps for these sizes may be obtained from the Waltham Watch Co. The number of threads is given as an even number per inch, but the diameter of the thread is measured in millimeters, the company employing the metric system. A column is given in the table, showing the diameter of the thread in inches and the diameter of the tap drill is also given in inches.

WATCH SCREW THREADS
(Waltham Watch Co. Standard)

No. of Tap	No. of Threads per Inch	Diam. of Thread, Millimeters	Diam. of Thread, Inches	Diam. of Tap Drill, Millimeters	Diam. of Tap Drill, Inches
1	110	1.50	0.0591	1.32	0.0520
3	110	1.20	0.0473	1.02	0.0402
5	120	1.10	0.0433	0.95	0.0374
7	140	1.00	0.0394	0.85	0.0335
9	160	0.93	0.0366	0.71	0.0280
11	170	1.34	0.0528	1.22	0.0481
13	180	1.00	0.0394	0.85	0.0335
15	180	0.83	0.0327	0.71	0.0280
17	200	0.65	0.0256	0.54	0.0213
19	220	0.55	0.0217	0.45	0.0177
21	240	0.45	0.0177	0.34	0.0134
23	254	0.35	0.0138	0.27	0.0106

Machinery

* * *

THE QUENCHING OF STEEL

Shipley N. Brayshaw in a lecture on "The Quenching of Steel," delivered before a recent meeting of the Huddersfield Engineering Society, Huddersfield, England, claimed that the age of water had a great deal to do with its quenching powers He also stated that some waters were more efficient than others and instanced the water of the River Don in Sheffield, which is carried away in barrels for quenching purposes, some of it even going to the United States. He did not state what peculiar properties the River Don water possessed.

Mr. Brayshaw discussed the properties which determine the value of any quenching liquid, and pointed out that the main items of consideration were specific gravity, specific heat, boiling point, conductivity and fluidity. He laid down as the ideal quenching medium one that was fluid from the temperatures of 100 degrees C. to 800 degrees C., of fairly high specific gravity and of fairly good specific heat. A quenching bath of this fluid would give a glassy hardness to tools, but the quenching should be carried out at such a temperature that the heat left in the parts would prevent breakage.

CUTTING AND DRAWING COMPOUNDS AND OILS

All metal cutting and grinding operations common to the machine shop can be done dry, but water or oil used as a coolant and lubricant lengthens the life of cutting tools, carries off the heat generated, and promotes general efficiency. The theory of the action of lubricants used for cutting operations is not altogether clear. It seems impossible that the point of a lathe tool deeply buried in steel can be lubricated by any compound flowing on the cut. It is clear, however, that the compound lubricates the chip and causes it to slide more easily off the heel of the tool. Most important probably is the fact that it reduces the temperature of the tool by carrying away the heat generated in displacing the chip.

Water alone is an excellent coolant, but its use is objectionable because it rusts the work and machines. Soda mixed with water prevents rusting and makes a compound that has some lubricating quality. Graphite and water in the colloidal form is also a very excellent lubricant and coolant and is free from rusting effect. Pure lard oil probably is the best lubricant for parting tools, screw cutting, screw machine operations, etc., but its cost is high and it presents some danger of infection of abrasions on the hands of operators. Soap-suds are excellent as a coolant and lubricant, and homemade soap compounds are much used. Soap solutions, soluble oils and other manufactured compounds placed on the market under various trade-names are cheap, effective and generally safe to use. The following list of cutting compounds and oils having distinguishing trade-names was compiled from information furnished by the various manufacturers whose names appear, and is given for general convenience in identifying cutting compounds and their makers.

Name	Manufacturer
A1	White & Bagley Co., Worcester, Mass.
Accrus	Internat'l Lubricants Co., Chicago.
Acme	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Advance	Advance G. & C. Co., Jackson, Mich.
Ajax	Phoenix Oil Co., Cleveland, Ohio.
A L A	A. L. A. Mfg. & Sup. Co., N. Y. City.
Amalie	L. Sonneborn Sons, Inc., N. Y. City.
American	American Oil Co., Jackson, Mich.
Amoco	American Oil Co., Jackson, Mich.
Anchor	Anchor Oil & Chem. Co., Cleveland, O.
Aquadag	Acheson Gr'ph'te Co., Ni'g'ra Falls
Aqualene	Crescent Oil Co., Inc., New York City.
Baker	Wm. T. Baker, Inc., Jersey City, N. J.
Baum	Baum's Castorine Co., Rome, N. Y.
Bison	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Buckeye	Moore Oil Co., Cincinnati, Ohio.
Cascade	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Challenge	Magie Bros., Chicago, Ill.
Climax Perfection	Climax Refining Co., Cleveland, Ohio.
Cookcom	N. B. Cook Oil Co., New York City.
Corliss	Corliss Supply Co., St. Louis, Mo.
Crescent	S. O. Co. of Ind., Chicago, Ill.
Cut-Rite	Phoenix Oil Co., Cleveland, Ohio.
Cutol	W. C. Robinson & Son Co., Baltimore.
Duocene	Crescent Oil Co., New York City.
Economy	White & Bagley Co., Worcester, Mass.
Emulso	Bayerson Oil Works, Erie, Pa.
Emulsol	Paragon Refining Co., Toledo, Ohio.
Endurance	Endurance Autoil Co., Muncie, Ind.
Ex-el-ard	Buffalo Specialty Co., Buffalo, N. Y.
Faultless	Hawkeye Oil Co., Waterloo, Ia.
501	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Forster	Forster P'nt & Mfg. Co., Winona, Mn.
Gargoyle	Vacuum Oil Co., New York City.
Germania Lubro	Germania Refining Co., Oil City, Pa.
Green	Monahan Antiseptic Co., Chicago, Ill.
Green Oil Soap	Monahan Antiseptic Co., Chicago, Ill.
Harris	Harris Oil Co., Providence, R. I.
Hosmer	G. A. Hosmer Co., Buffalo, N. Y.
Houghtolard	E. F. Houghton & Co., Phila., Pa.
Hydroil	B. G. Pratt Co., New York City.
Justrite	Crescent Oil Co., Inc., New York City.
Keep-Kool	Phoenix Oil Co., Cleveland, Ohio.
Key Brand	Interstate Chem'c'l Co., Jersey City.
Key Cote	Interstate Chem'c'l Co., Jersey City.
Key Sol	Interstate Chem'c'l Co., Jersey City.
Lardral	Farr Mfg. Co., New York City.
L-O	G. Whitfield Richards, Phila., Pa.
Lube-a-Tube	G. Whitfield Richards, Phila., Pa.
Lube-Well	G. Whitfield Richards, Phila., Pa.
Lubricool	Farr Mfg. Co., New York City.
Lubro	G. Whitfield Richards, Phila., Pa.
Magic	Fiske Refining Co., New York City.
Marnile	George A. Haws, Inc., N. Y. City.
Matchless	S. O. Co. of Ind., Chicago, Ill.
Mineral Lard	Union Petroleum Co., Phila., Pa.
Minlardo	American Oil Co., Jackson, Mich.
Minolard	White & Bagley Co., Worcester, Mass.
Minolene	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Misceo	E. F. Houghton & Co., Phila., Pa.
Mogul	S. O. Co. of Ind., Chicago, Ill.
Mohawk	Mohawk Gr'd'g Paste Mg. Co., Albany.
Moores	Moore Oil Co., Cincinnati, Ohio.
Mystic	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Nagle Soluble	Ulco Oil Co., Detroit, Mich.
Near-a-Lard	G. Whitfield Richards, Phila., Pa.
No. 1	Moore Oil Co., Cincinnati, Ohio.
Nonesuch	G. Whitfield Richards, Phila., Pa.
Oakite	Oakley Chemical Co., N. Y. City.
Oildag	Acheson Gr'ph'te Co., Ni'g'ra Falls.
Opco Lardo	Am. Oil Products Co., Buffalo, N. Y.
Oriole	W. C. Robinson & Son Co., Baltimore.
Palubco	Penn. Lubricating Co., Pittsburg, Pa.
Paragon	Paragon Refining Co., Toledo, Ohio.
Paroleum	Borne, Scrymser Co., New York City.
Peerless	Racine Tool & Mach. Co., Racine, Wis.
Pennant	Pierce Oil Corp., St. Louis, Mo.
Pensico	Carter Petroleum Co., Phila., Pa.
Perfection	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Petro-Lard-Oil	American Oil Co., Jackson, Mich.
Phoenix	Phoenix Oil Co., Cleveland, Ohio.
Plumbers	Standard Oil Co., of N. Y., N. Y. City.
Primus	Penn. Petroleum Sup. Co., Phila., Pa.
Reliable	Gen'r'l Oil Wks. Co., Indianapolis.
Robinson	W. C. Robinson & Son Co., Baltimore.
Royal	Castle Lubricant Co., N. Y. City.
Solcut	E. F. Houghton & Co., Phila., Pa.
Sol-O	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Sol-O-Ene	Anchor Oil & Chem. Co., Cleveland, O.
Solubo	Moore Oil Co., Cincinnati, Ohio.
Solucene	Crescent Oil Co., Inc., New York City.
Soluline	Star Lub. Oil Co., Cleveland, Ohio.
Solvoline	Phoenix Oil Co., Cleveland, Ohio.
Standard	Standard Oil Co. of N. Y., N. Y. City.
Sub-For-Lard	Anchor Oil & Chem. Co., Cleveland O.
Sullivan	Sullivan Oil Co., Chicago, Ill.
Texaco	Texas Co., New York City.
3A	Catar'ct Ref. & Mfg. Co., Buffalo, N. Y.
Triprocess	Garnet Co., Allentown, Pa.
Ulco	Ulco Oil Co., Detroit, Mich.
Union	Standard Oil Co. of N. Y., N. Y. City.
Unity	Sullivan Oil Co., Chicago, Ill.
Velox	W. C. Robinson & Son Co., Baltimore.
Velvet	Advance Oil Co., Oil City, Pa.
Viscos Cutting	National Oil & Sup. Co., Newark, N. J.
Viscos Min'r'l'zed Lard	National Oil & Sup. Co., Newark, N. J.
Viscos Soluble	National Oil & Sup. Co., Newark, N. J.
Viscosity	Cataract Ref. & Mfg. Co., Buffalo, N.Y.
Warley	Thomas O. Warley & Co., Phila., Pa.
Waverly	Waverly Oil Wks. Co., Pittsburg, Pa.
XX	Indian Refining Co., New York City.

* * *

An interesting and helpful article on the value of trade literature by James H. Collins appeared in the January 15 number of the *Saturday Evening Post*. Mr. Collins says business books are being published in large numbers, technical journals are growing better, and printed helpers of all sorts are being made available. More and more the American business man is asking "Where can I get good books on so and so?" This is a time when the printed word is utilized by both the big men and the little ones in their jobs. It shows them what others have done and are doing, makes their work fit into the general business scheme, and prevents waste. To find and use the best printed things about ones work is so much a part of present-day business that large concerns are installing business libraries, and no man is so small or his job so new or unusual that some help cannot be found in print—if a fellow only knows where to find it.

* * *

It is estimated that the total amount of radium in all the known radium-carrying ore deposits in the world is about one pound. At the present time, about one-half ounce of this has been extracted from the ores, and this amount constitutes the total store of radium available. It is believed that, at present prices, there is a demand for about two ounces of radium, but the production is not carried on to an extent to meet the demand.

SETTING THE PLANER RADIUS ATTACHMENT

A METHOD OF PLANING TRUE CIRCULAR ARCS

BY JOHN LYNCH*

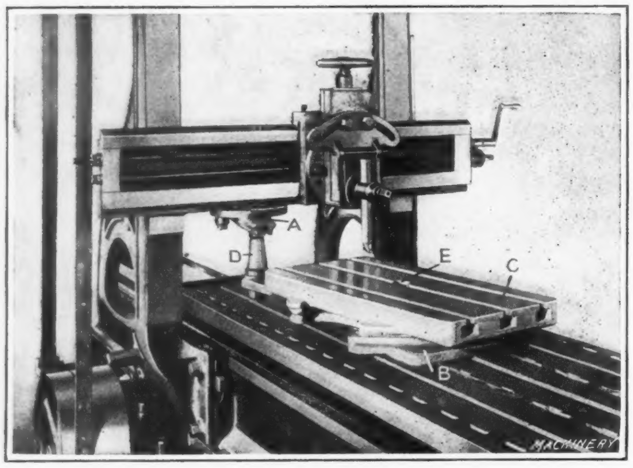


Fig. 1. H. B. Underwood & Co.'s Radius Attachment for Planer

THERE are many machinists who do not fully understand the operation of planing curved work, and some foremen have trouble in handling a job of this kind. It is the purpose of this article to explain the use of a simple attachment, made by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., which enables work to be planed to any desired radius of curvature. Referring to Fig. 1, it will be seen that this attachment consists of a longitudinally slotted guide arm *A* provided with an index head for setting the arm at various angles with the line of travel on the planer table, a base *B*, which is secured to the table of the planer, and a work-table *C* that is pivoted on this base. The work-table carries a pin *D* at one of its corners, which projects into the slot in the guide arm *A*, and as the planer table reciprocates back and forth, the movement of the pin *D* in the guide arm causes the work-table to swing on its pivot *E*, with the result that the work follows the arc of a circle in passing under the planer tool. By setting the guide arm at the required angle, the work may be planed to any radius of curvature which comes within the capacity of the attachment.

When the attachment is set up in accordance with the usual method, the curve obtained is a close approximation of a circle when the arc to be planed is not too long; but if it is required to plane an arc of considerable length, the discrepancy from a true circular form will be apparent. For use in cases where a high degree of accuracy is required and where the work is of such a nature that it cannot be handled on a lathe or boring mill, I have developed a method of setting up the planer radius attachment which produces a high degree of accuracy. In setting up the attachment according to this method, the following points must be observed: The pivot on which the work-table swings should be located over the center of the planer table, and the planer tool should be set so that it is over a line drawn through the pivot and parallel to the line of travel of the planer table. The tool should be located at such a distance in front of the cross-rail as to lie at the point of intersection of the line through the pivot and a line through the center of the guide arm. This location of the tool is shown diagrammatically in Fig. 2, which illustrates positive

* Address: Inspection Department, Navy Yard, Boston, Mass.

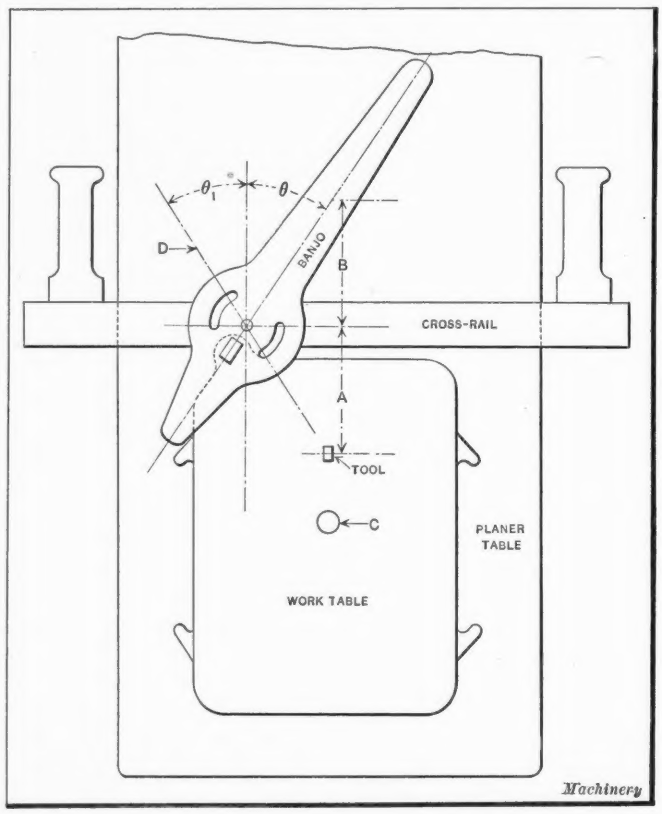
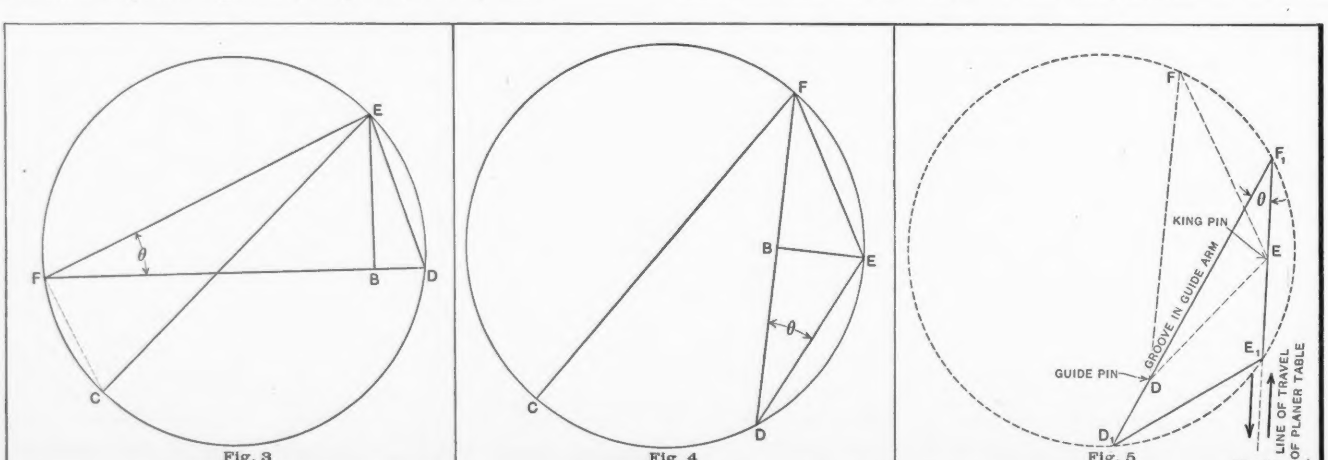


Fig. 2. Diagram showing Method of setting up Attachment to plane a True Circular Arc

and negative settings of the guide arm. With the guide arm set to an angle θ, the attachment will plane a curve of the same radius as if the guide arm were set to an angle θ_1, but the direction of curvature will be opposite. Both curves will be true arcs of circles. It will, of course, be evident that angle θ_1 is equal to θ, and it may be mentioned that the distances *A* and *B* are equal. The location of the tool is the same in both cases, being at the intersection of the line



Figs. 3 to 5. Diagrams illustrating Derivation of Formula for Angle at which to set Guide Arm to plane Work to Any Required Radius R

through pivot C parallel to the line of travel of the planer table and line D which is the center line of the guide arm when set to an angle θ_1 with the line of travel of the planer table.

It has been stated that different radii of curvature are obtained by setting the guide arm at various angles, and the following formula determines the required angular setting to plane any desired radius of curvature:

$$\frac{11.25}{R} = \cos\theta$$

where R = required radius of curvature;
θ = angle at which attachment must be set.

The derivation of this formula is based upon the following:

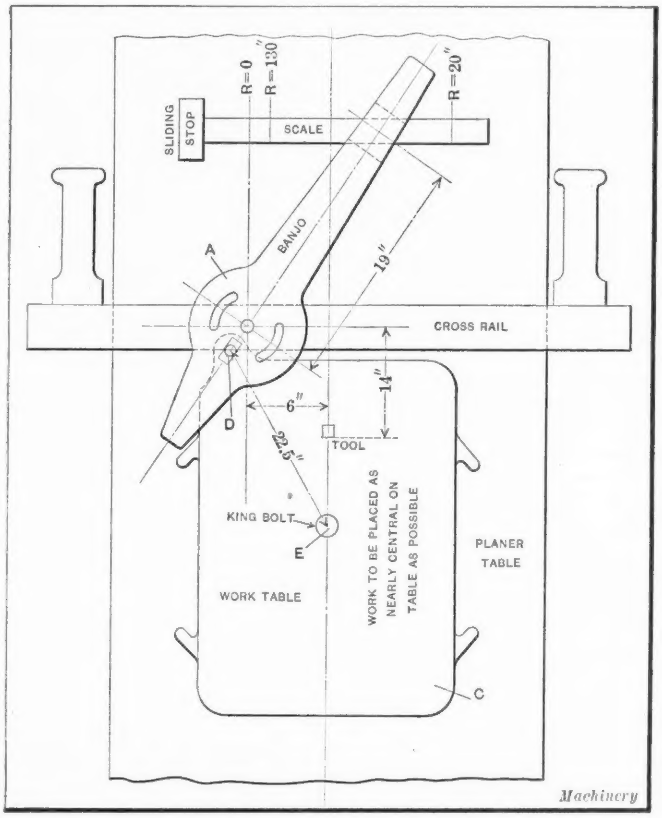


Fig. 6. Diagram showing Method recommended by H. B. Underwood & Co. for setting up Attachment

We know from geometry that in any triangle the product of any two sides is equal to the diameter of the circumscribed circle multiplied by a perpendicular drawn to the third side from the apex of the opposite angle. Bearing this fact in mind, we see from Fig. 3:

$$EC \times EB = ED \times EF$$

$$\frac{ED}{EC} = \frac{EB}{EF}$$

$$\text{But } \frac{EB}{EF} = \sin\theta;$$

EC = diameter D of circumscribed circle.

Let E indicate the center of the pivot about which the work-table oscillates, and D the center of the pin which engages the guide arm. The distance between points E and D is fixed, and on the planer radius attachment this distance is 22.5 inches. Hence we have the following equation:

$$\frac{22.5}{D} = \sin\theta$$

$$\frac{11.25}{R} = \sin\theta$$

where R = required radius of curvature for the work; and θ = angle at which attachment must be set.

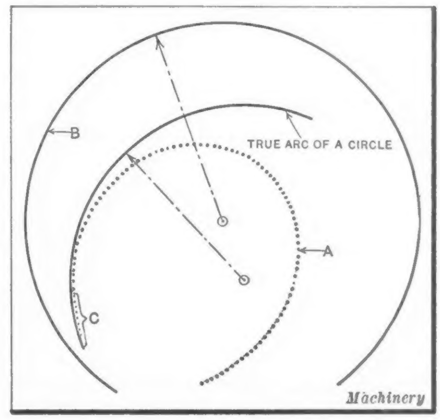


Fig. 7. Arc of True Circle is planed when Attachment is properly set; otherwise, Curve will be of Some Such Form as shown by Dotted Line

The preceding formula assumes that the reading of the graduated head is zero when the guide arm is set parallel to the line of travel of the planer table. As a matter of fact, the index head is graduated in such a way as to read 90 degrees when the guide arm is set parallel to the line of travel of the table. We know from trigonometry that:

$$\sin\theta = \cos(90 \text{ degrees} - \theta)$$

Hence the formula for determining the angle at which to set the radius attachment for planing any required work is:

$$\frac{11.25}{R} = \cos\theta.$$

In deriving the preceding formula for setting the planer radius attachment, use was made of a theorem that the product of any two sides of a triangle is equal to the product of the diameter of the circumscribed circle multiplied by a perpendicular dropped to the third side from the apex of the opposite angle. The proof of this may be briefly given as follows: In Fig. 3 it is required to prove that:

$$EC \times EB = ED \times EF$$

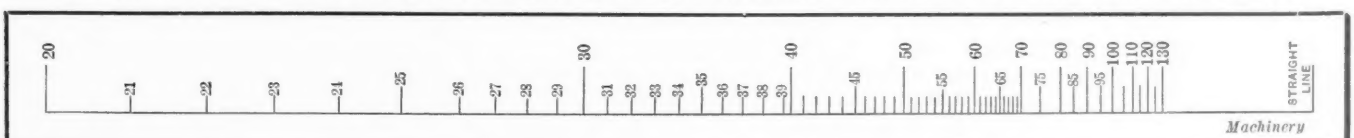
In right triangles EFC and EBD, angle C = angle D. As a result, all of the corresponding angles are respectively equal and the triangles are similar; hence, homologous sides of the triangles are proportional, and we have:

$$\frac{EC}{ED} = \frac{EF}{EB}$$

Therefore, $EC \times EB = ED \times EF$.

The theorem just proved is true for all triangles, so that it holds in the case shown in Fig. 4 where the conditions are the same as those that obtain in the planer radius attachment shown diagrammatically in Fig. 5. In this illustration the line E_1F_1 represents the line of travel of the planer table, D_1F_1 the center line of the groove in the guide arm, E the "king pin" or pivot about which the work-table oscillates, and D the pin which engages the guide arm. The reciprocating travel of the planer table is indicated in this illustration by the reversed arrows. When the planer is in motion, the pin E will move forward to the position indicated by E_1; and this

VALUES USED IN LAYING OUT SCALE FOR SETTING PLANER RADIUS ATTACHMENT



Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches	Radius R, Inches	D, Inches
20	13.40	35	6.41	50	4.32	65	3.28	80	2.65	95	2.23	110	1.91	125	1.67
25	9.63	40	5.52	55	3.90	70	3.04	85	2.50	100	2.11	115	1.82	130	1.61
30	7.65	45	4.84	60	3.56	75	2.85	90	2.35	105	2.01	120	1.74	∞	0

Machinery

Note: D = distance of radius graduation from straight-line graduation.

movement will cause the guide pin D to move forward to the point indicated by D_1. Similarly, the point F will move to point F_1. It will be seen that the point F follows the circumference of a circle, the movement of this point indicating the manner in which the work moves under the planer tool to generate the arc of a true circle.

The method of using this attachment will probably be better understood by carrying through the actual calculation involved in setting up the attachment to plane work to a given radius of curvature. Suppose it is required to plane a piece with a radius of curvature of 42 inches. Using the formula previously determined for finding the required angle θ at which to set the attachment, we have:

$$\frac{11.25}{R} = \cos\theta$$

$$\frac{11.25}{42} = 0.2678$$

$$\theta = 74 \text{ degrees, } 32 \text{ minutes}$$

It has been explained that in order to plane a true circular arc it is necessary to have the planer tool located at the intersection of the center line of the groove in the guide arm and a line drawn through the pivot pin parallel to the line of travel of the planer table. Unless these instructions are followed the true arc of a circle will not be obtained, the curve generated being some such form as shown by the dotted line A in Fig. 7; but when properly set the attachment will generate the arc of a true circle B. Curve A is a close approximation of a true circular arc when only a short length of the arc is considered. This is shown by the fact that the dotted curve A almost coincides with the true circular arc for the portions of the two curves covered by bracket C.

[For the purpose of setting the attachment for planing various radii of curvature, H. B. Underwood & Co. give the following instructions: The center of the guide arm or "banjo" is located 6 inches to the left of the center line of the planer table when viewed from the front of the machine, as shown in Fig. 6; the planer tool is set over the center line of the planer table, at a distance of 14 inches in front of a line drawn through the center of the guide arm and parallel to the cross-rail; and the baseplate of the attachment is bolted to the planer table in such a way that the pivot or "king pin" is set on the center line of the planer table. To provide for setting up the attachment for planing work to curves for various radii of curvature, a scale has been developed, which is laid out according to the results presented in the accompanying table (and is illustrated at the top of the table), from which it will be seen that provision is made for planing work with radii of curvature ranging from 20 to 130 inches. The curve which has an infinite radius of curvature is a straight line, and it will be evident that such a curve is generated by the attachment when the slot in the guide arm is parallel to the line of travel of the planer table. In using the scale, it is laid perpendicular to the center line of the planer table at a point 19 inches from the center of the "banjo" measured along the guide arm as shown in Fig. 6. The use of this scale provides a rapid method of setting the guide arm, and this method of setting up the attachment on the planer possesses a noteworthy advantage over Mr. Lynch's method in that the position of the tool is fixed for all curves, so that no special equipment is necessary for securing the tool to the cross-rail.—EDITOR.]

* * *

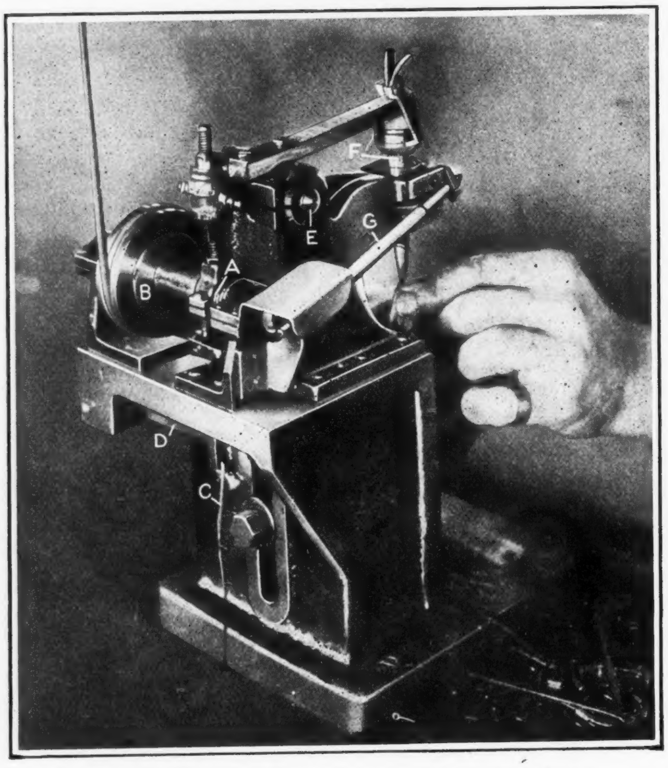
MONTHLY MEETING OF THE A. S. M. E.

At the monthly meeting of the American Society of Mechanical Engineers, held in the Engineering Society's Bldg. in New York City, February 8, T. Russell Robinson, statistical engineer for W. S. Barstow & Co., Inc., New York City, spoke on the subject "Ways of Presenting Data for Executive Purposes." The paper was prepared to present in a complete manner the methods used for showing, by means of diagrams, results obtained in the operation of an industrial undertaking. Comparisons were made with tabulated data, indicating how much clearer the results may be made by means of diagrams. While the paper related particularly to the performance of public service corporations, the methods can be easily adapted to the keeping of any continuous records. Preceding the meeting, an informal dinner was held at a restaurant close to the Engineering Society's building, for the purpose of bringing together the members and enabling them to become acquainted.

MINIATURE RIVETING HAMMERS

The miniature riveting hammer shown in the illustration was patterned after the well-known Bradley hammer; it is so small that it can be readily lifted with one hand, as will be inferred by comparing it with the size of the man's hand. This little riveting hammer is one of fifty or more used in the Remington Typewriter Co.'s plant at Ilion, N. Y. for riveting typewriter parts.

The origin of this small helve type of hammer dates back several years, when it was desired to head over very small rivets for typewriter riveting, leaving them with perfectly shaped heads. Trouble was experienced in securing the right kind of a head with the regular type of riveting machine, and it was decided to try a helve hammer. Accordingly, an arrangement was made with the C. C. Bradley & Son Co. of Syracuse, N. Y., whereby the standard Bradley helve hammer was copied in miniature with slight variations, the parts



A Helve Hammer, made One-sixteenth Usual Size, for Riveting

being made one-sixteenth the size of those in the regulation hammer. The machine has proved very successful, as the rubber cushions and the hickory helve give an elastic blow, allowing the metal to "flow" under the hammer.

The hammer is operated by an eccentric on the driving shaft that may be seen at A at the rear of the hammer. The driving pulley runs continuously, but it is fitted with a friction clutch B so that while the pulley nominally rotates loosely on the driving shaft, it rotates the shaft also when the clutch is thrown in. The clutch is operated by a foot-pedal through a wire C and clutch lever D. When the shaft is made to rotate by engaging the clutch, the helve is reciprocated, being hinged on pin E. The riveting punch is at the end of the helve at F, being mounted upon a rubber cushion supported by the helve. The driving end of the helve also "rides" on rubber cushions.

At the end of the driving shaft opposite the clutch is a bevel gear connection to a worm shaft G that extends to the front of the machine. This shaft terminates in a worm and meshes with a worm-wheel that turns the riveting anvil while the operation is going on, thus assisting in making the head uniform. The machine is extremely sensitive and very rapid in its operation, striking 4500 blows per minute if desired. The action is very flexible, it being possible to strike the blows slowly or rapidly as desired.

This type of riveting machine is now made in several sizes for the market by the High Speed Hammer Co., Rochester, N. Y.

KEEPING MULTIPLE DRILLING MACHINES AT WORK

After making a heavy investment in a machine tool, the ideal condition to maintain would be to keep it working all the time. This is seldom possible, however, owing to the fact that between operations a certain time is taken for removing work from the jigs and replacing new work for the next operation. During such times, the investment of money in the machine tool is still going on, but the machine is standing idle.

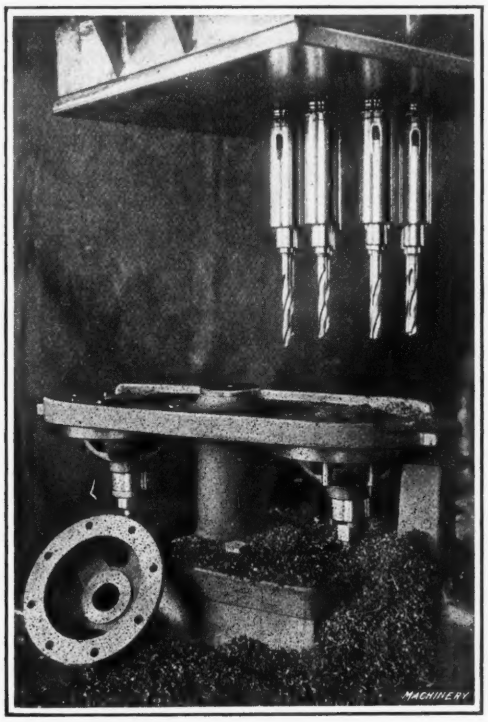


Fig. 1. Two-station Type of Drilling Jig

The New Process Gear Corporation of Syracuse, N. Y., manufacturer of automobile gears, evidently had this point in mind when designing the two drilling fixtures shown in Figs. 1 and 2 that are used on the National Automatic Tool Co.'s multiple drilling machines. The object of these two jigs is to provide a method by which the drilling machine will be kept at work drilling all the time even while the man is removing and replacing work. In Fig. 1 the work being done is the drilling of eight 5/16-inch holes through a 1/4-inch flange on a malleable iron differential gear-case half. The method of using the jig will be apparent at a glance. The jig is of the two-station type and the work is bolted on from the under side, being located on a central stud. The body plate of the fixture carries eight bushings for the 5/16-inch drills. While the drilling operation is proceeding, the operator is removing the piece previously drilled and inserting a new one at the station not in use. The drilling operation gives him just time enough to substitute a new case for the drilled one, index the jig, start drilling the new piece, and then proceed to remove the case just drilled.

The jig in Fig. 2, for use in drilling drop-forged steel drive-gears, is even more interesting in its operation, as it is of the three-station type. The work to be performed is the drilling of four 9/16-inch holes and eight 5/16-inch holes through a flange that is 9/16 inch thick. The drilling is done on a twelve-spindle drilling machine in which the spindles are arranged in two groups of four and eight. The jig has three stations, as shown in the illustration, and is locked in each position by the pin shown at the left. The operator clamps a gear at the front station, indexes the jig to the right and the four 9/16-inch drills go through the work. He then indexes a second time and the same gear blank is drilled again with eight 5/16-inch drills. At the third indexing the piece is brought to the front again, finished, and removed and a new one is inserted. Thus, after every indexing the four 9/16-inch holes are drilled by the first group of spindles simultaneously with the drilling of the eight 5/16-inch holes by the second group of spindles, and during this time the operator is taking off a finished piece and replacing it with a new one.

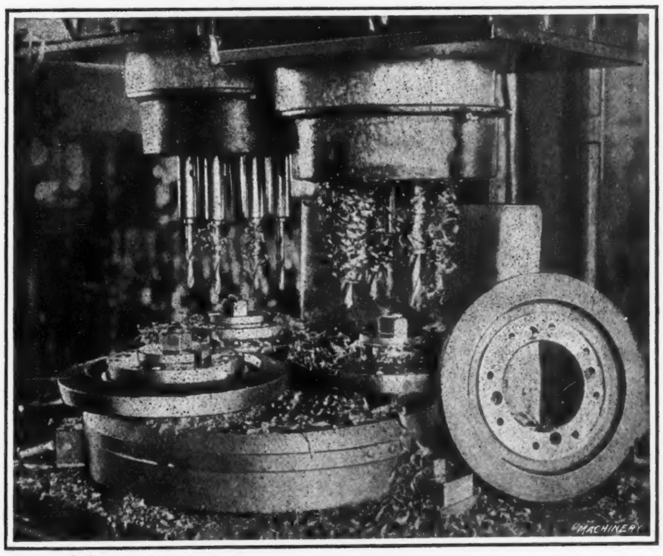


Fig. 2. Three-station Type of Drilling Jig

As the New Process Gear Corporation factory is running night and day, it is evident that these drilling machines spend almost 100 per cent of their time in actually drilling—and none in waiting to drill. C. L. L.

* * *

THE LITTLE SHOP IN THE BACK YARD

BY A. P. PRESS

Some months ago we wrote you about "Bill and His Little Shop," and perhaps you would like to hear the rest of the story. Bill has gone. The shop got too small to hold him and his work. It fairly pushed off one side of the building, until he had to do all his pipe work out in the yard, and even then the shop was too small and he had to run nights to get the work done.

This was the way he happened to get out: A member of a large concern came around one day and saw what Bill was doing. He got interested in Bill and his work, and now Bill has a shop nearly 200 feet long, and we had the pleasure of selling him a good power plant for it. (We got our money too.) We were up to see him a few days ago. He has a nice office in one end of his shop with a little drafting-room attached, and while he has a typewriter, Mrs. Bill doesn't run it any more.

Bill (by the way, we must not call him Bill any more) is now a manufacturer in every sense of the word, but when we look over our back fence at the little shop now tenantless, we feel both glad and sorry—glad for Bill because he has branched out and done so well, and sorry because the little shop that used to hum with activity and business, now, like the harp that hung on Tara's walls, is "silent, drear, and dead." Perhaps the environment has something to do with Billy's success in getting ahead. From our back window you can look and see no less than six of these little shops. They don't blow any whistle, although every one has an engine lathe and some of them a complete equipment. They start in about seven o'clock (P. M. mind you), and their lights are never turned out, when we "turn in." The one nearest to us is building an automatic transmission for an automobile. That is, as you go up a grade, the car automatically drops into third speed, and if the grade is still too great for the power of the engine, it drops into second, and then into first if necessary. He has been working on it two years now, and while to us it seems perfect, you know it is hard for a mother to give up her baby, and so he is still at it. The next firm up the back fence is doing die work, and has expert mechanics of the highest ability, but many a time they have made me a set of tools (and they were good ones, too) for half what I could get them made for elsewhere. There is something funny about it. A man puts up a kick when you ask him to work overtime for less than time and a half, but he will go cheerfully into his own shop and work on a job that doesn't pay him more than half his regular day rate.

Bless the little shops in the back yard. They may keep us awake nights, but they are turning out a product which can be produced in no other way, and that is mechanics who handle the business end as well as the mechanical details, and make a success of both.

MODERN MACHINE VISES AND APPLICATIONS

EXAMPLES SHOWING THE UNIVERSAL RANGE OF WORK TO WHICH THIS MACHINE FIXTURE MAY BE ADAPTED

BY FRANK H. MAYOH*

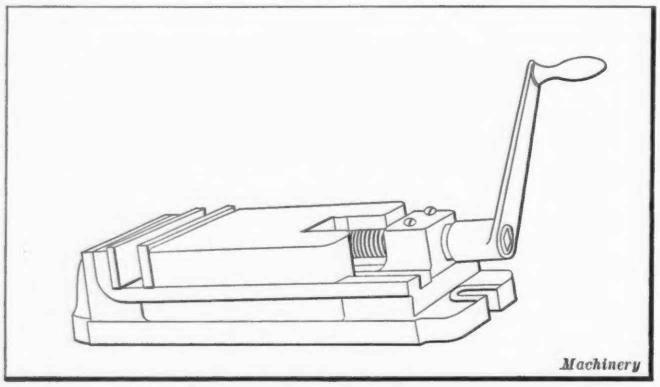


Fig. 1. Plain Flanged Vise

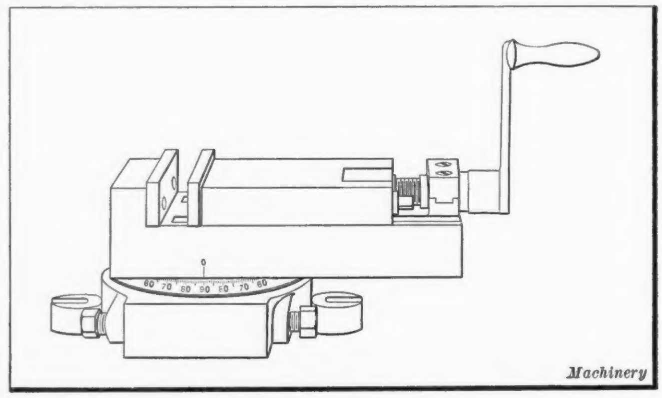


Fig. 2. Typical Swivel Vise

THE machine vise so commonly used on milling machines and other machine tools is as nearly a universal fixture of simple design as can be found in machine tool equipment. The object of this article is to describe some of the uses of modern machine vises in manufacturing and to give examples to illustrate the wide range of work for which they are adapted. The article will show that these vises can be adapted at slight expense, as compared with high-priced special jigs and fixtures, for a wide range of work. Many shop executives, not desiring to build expensive fixtures for the production of a few hundred pieces only, send jobs into the shop and let the machine operators do the work with inadequate tool equipment. A few dollars spent on special vise jaws would often cut down production cost of parts of moderate size very materially. Of course it is true that the vise might not be the cheapest fixture for holding the work were there enough parts to warrant making more elaborate tool equipment.

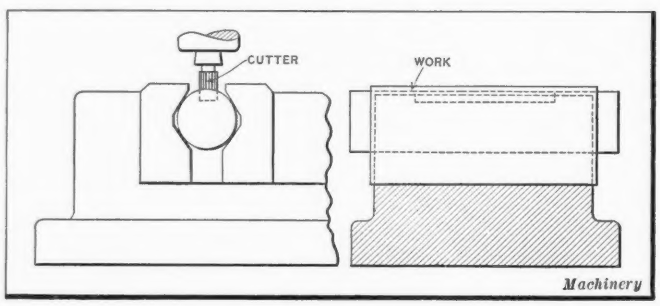


Fig. 3. Vee Jaws for Round Work

Examples of jaw construction for plain and universal vises are shown in the accompanying illustrations. Some of these vises require attachments that are regularly furnished by the makers, while others must be adapted to the work by the user. One of the simplest styles of modern vise is that shown in Fig. 1. It has no angular adjustment and is adapted only for work having parallel sides or square ends. The swivel vise shown

* Address 87 Samuel Ave., Pawtucket, R. I.

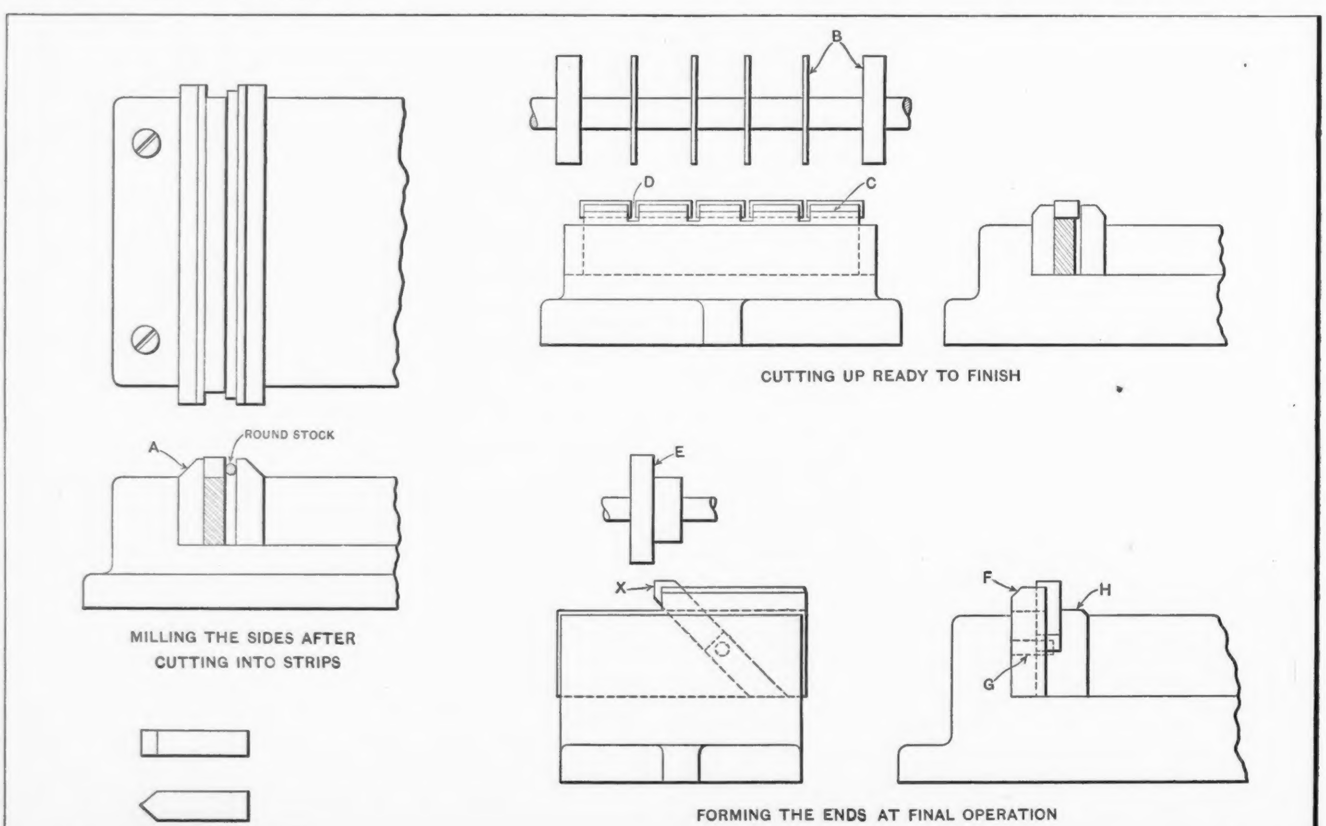


Fig. 4. Method of manufacturing Part X in Vise Jaws

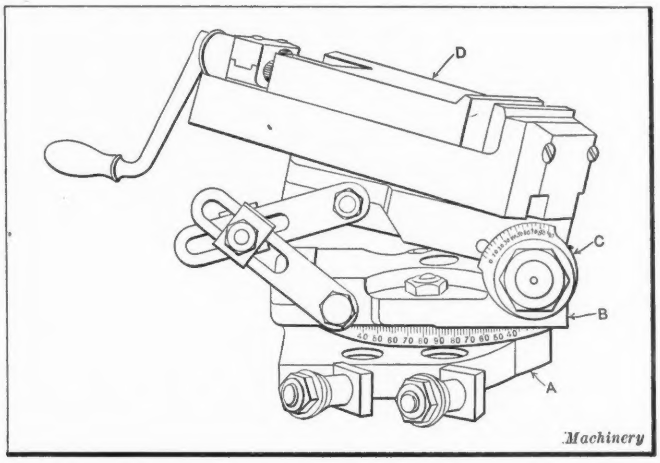


Fig. 5. Toolmakers' Universal Vise

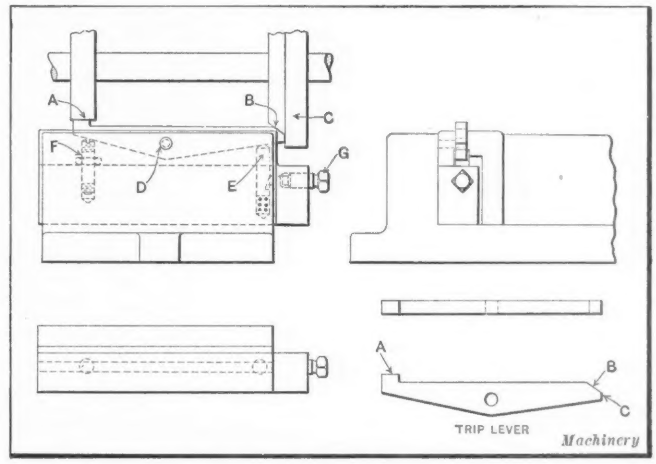


Fig. 6. Gang Milling Trip Lever in Special Vise Jaws

in Fig. 2 has angular adjustment in the horizontal plane only. The plain vise is to be preferred to the angular vise for straight work, as it is cheaper, sets lower on the table and is more rigid. Thus it may be operated under heavier cuts with less vibration.

Perhaps the most highly developed vise as far as mechanical construction is concerned, is the toolmakers' universal vise illustrated in Fig. 5. This is used for fine work and can be set to machine compound angles by bolting the base *A* to the table or platen of a machine. The upper portion *B* may be swiveled to the desired angle, and the reading taken from the scale at its base. Elevating the operating jaw end of the vise to a reading taken from the dial *C* on the stud gives another angle. When desired, the vise proper *D* may be swiveled on its base to still another angle, thus making three independent settings in all. This vise, when rigidly clamped, makes a fairly substantial tool.

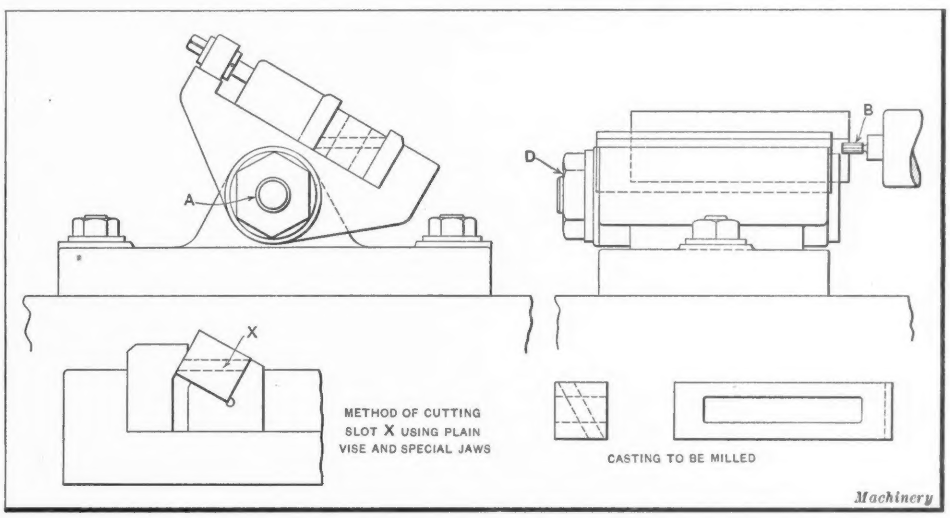


Fig. 7. End-milling a Slot in Swivel Vise

Referring to Fig. 4, examples of the use of a plain flanged vise for milling are shown. The piece *X* is made in three sets of jaws from bar stock. The rough bars come to the first operation in lengths of about twelve inches. The four sides are milled consecutively, and to insure squareness, the bar is forced against the solid vise jaw *A* with a piece of round stock. This insures the work being squared up from one side only, this side always being the last to be milled. A parallel is placed under the work to maintain the correct height. The bars are next cut to a length slightly greater than the finished product by saws and side

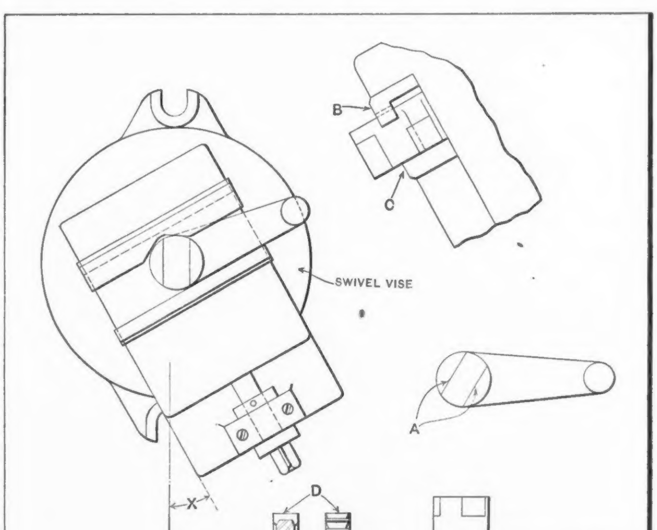


Fig. 8. Milling Flats on Lever Boss in Swivel Vise

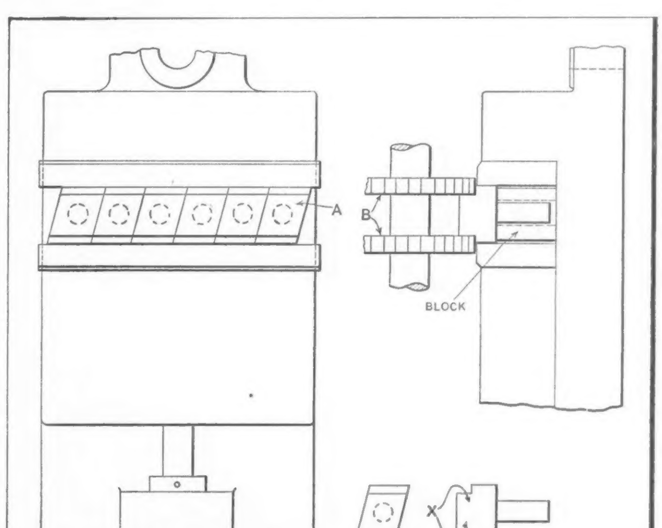


Fig. 9. Work held for Gang Milling

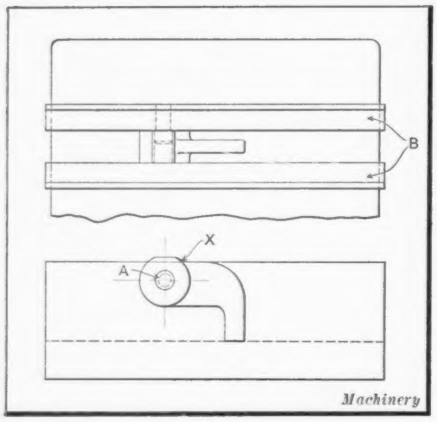


Fig. 10. Locating Work on a Pin in Vise Jaws

milling cutters *B*. The work is held in a set of special vise jaws *C*, which have slots cut where the saws come at *D*. For the final operation, the vise jaw equipment consists of one special jaw and one standard jaw. The operation — milling the angles—is performed with face and side milling cutters *E*. The work *X* is held at an angle in the stationary jaw *F*, locating in a slot against the pin *G* and being clamped by the standard movable jaw *H*. There is a distinct advantage in holding the work at an angle. Since the included angle in this case is ninety degrees, the work is thrown over at an angle of forty-five degrees, enabling a standard side and face milling cutter to be used. Should the included angle be more or less than ninety degrees, the work may be thrown over at one-half the included angle, and the milling can be accomplished with a standard side milling cutter and one special angular face milling cutter. This has an obvious advantage over milling with the work in a vertical position, as in that case two special angular cutters are required.

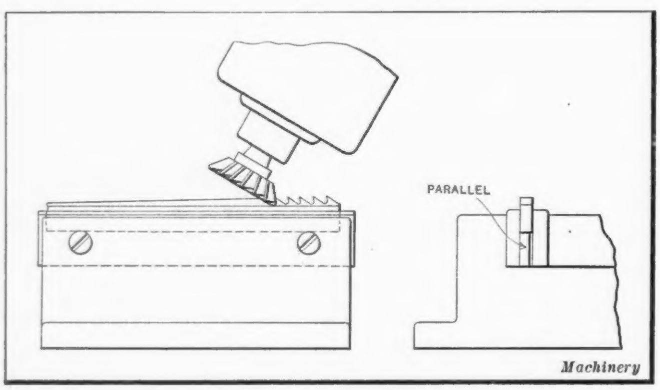


Fig. 11. Milling a Broach with Vertical Attachment and Angular Cutter

An example of work held in a swivel vise is shown in Fig. 8. This vise has one special and one standard jaw. The operations consist of flattening off both sides of the boss *A* in relation to the end of the work. This is accomplished by placing the work in the special vee jaw *B* and binding it with jaw *C*, then swiveling the vise to the desired angle and milling with the straddle milling cutters *D*. The parts are machined in duplicate very rapidly.

It is often necessary to machine work that requires to be supported at four or more points. A rough casting of this kind cannot be held by fixed jaws, and the best way to handle it is by means of a vise that has one equalizing jaw, as shown in Fig. 13. In this illustration the bosses on the work are being surface-milled with cutter *A*. The work is located in the fixed jaw *B* in the vee-shaped groove and clamped against the groove angles *C* by means of the two lugs *D* on the equalizer. This equalizer pivots about the point *E* and is held to the movable jaw *F* by the screw *G*.

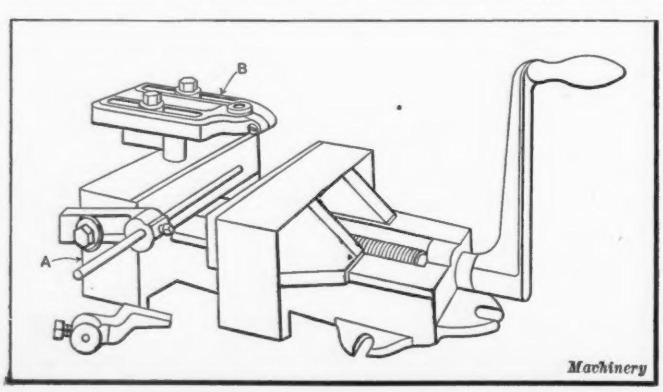


Fig. 12. Graham Vise with Jig Attachment

A very handy set of vise jaws are the vee-shaped jaws shown in Fig. 3, which may be used for milling keyways in shafts and for various other purposes where the work is round or of similar shape.

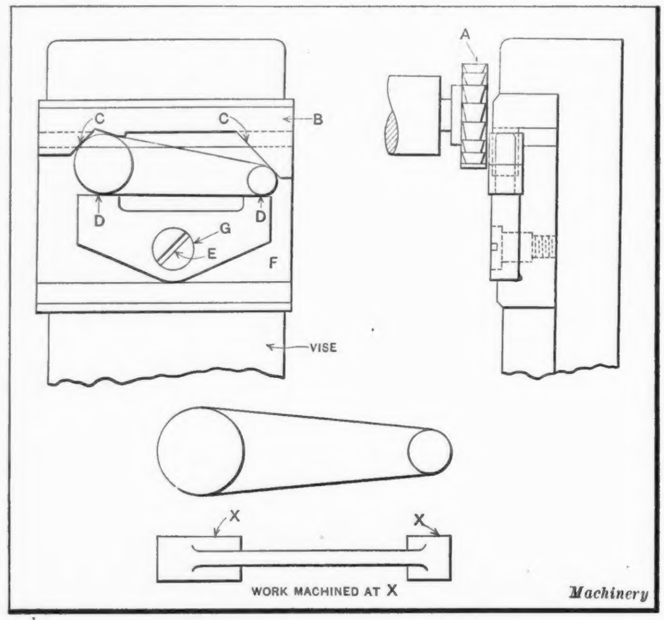


Fig. 13. Example of Equalizing Vise Jaw

Another type of swivel vise is illustrated in Fig. 7 in use on a horizontal milling machine for end-milling a slot across the end of a casting. The vise pivots about the stud *A* and is tilted to the desired angle for milling with cutter *B*. In the event of no vise of this type being on hand, the same result may be obtained by the use of a plain vise and two special jaws cut on an angle as shown.

Fig. 6 shows a gang milling operation on a small piece, using a spring pin, central stud and screw for locating the work. There are three cuts on this piece, milling the lug with surface mill *A*, milling the bevel with angular milling cutter *B* and milling the end with side milling cutter *C*. In placing the work in these vise jaws, it is slipped on the pin *D* and the movable jaw is brought up to just touch the work, when the

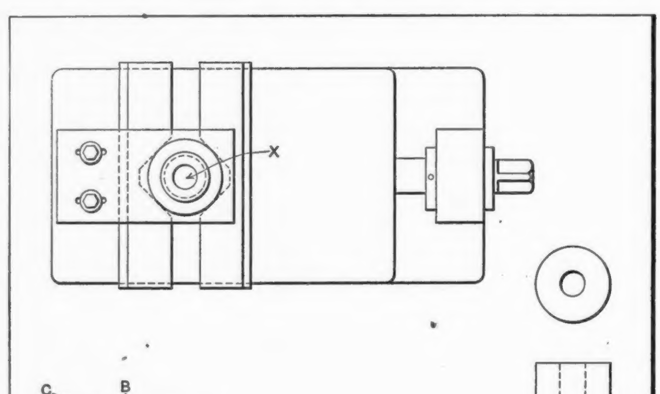


Fig. 14. Simple Vise with Jig Attachment

spring pin E is released, forcing the work against the screw F. In this position the spring pin is locked by the screw G; then the vise jaw is tightened, holding the work rigidly.

When setting up work, pins can often be used to good advantage under such conditions as locating from a hole and gripping on a boss as shown in Fig. 10. X is the work and A the locating pin. The jaws B are standard, except that a hole is made in the fixed jaw to receive the pin, which holds the

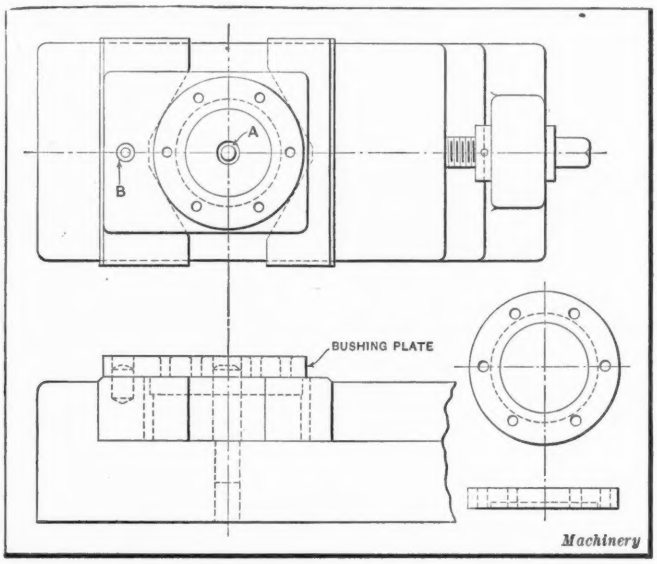


Fig. 15. Drilling Holes on a Circle with Removable Bushing Plate

work at the correct height. Further location of the work is obtained by the end resting on a parallel or the bottom of the vise in the position shown.

Other combinations for milling or planing in vise jaws are often made by holding two or more pieces at one time. Unless the portions of the work gripped between the jaws are finished fairly close, it is necessary to provide some means of compensation in order to grip all the pieces securely, as some of the pieces would be loose and pull out when machining began. An illustration of several pieces being held in a vise for gang

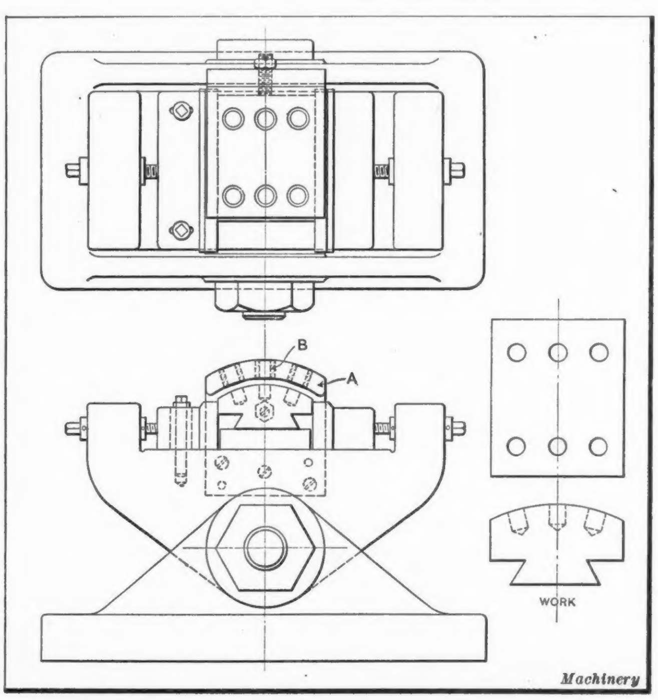


Fig. 16. Drilling Holes on an Angle in Special Vise

milling is shown in Fig. 9. Six pieces A are placed in the vise, resting on a block which has six clearance holes for the round shanks. Then the jaws are tightened in the usual manner and the sides X are straddle-milled with straddle milling cutters B.

A vise for milling broach teeth is shown in Fig. 11, where

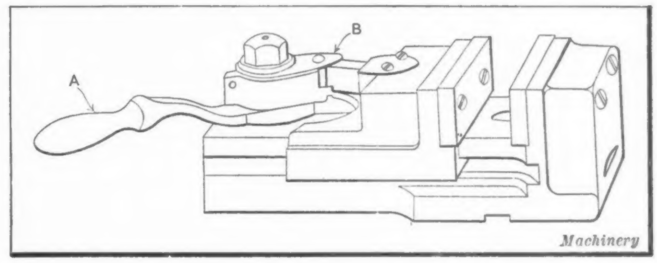


Fig. 17. Quick-action Vise

the angular cutter is held in the vertical milling attachment of a horizontal milling machine. The work is held in a plain vise and the cross-slide is fed in and out when taking the cuts. This arrangement permits a slight undercutting of the broach teeth, which is a very desirable feature.

Drilling in Vises

Although the foregoing examples have been of vises used in milling or planing operations, any of these may be used for drilling in combination with attachments for holding drill bushings or locating stops. There are now on the market vises furnished with jig attachments ready for use. One of these vises as made by the Graham Mfg. Co. is illustrated in

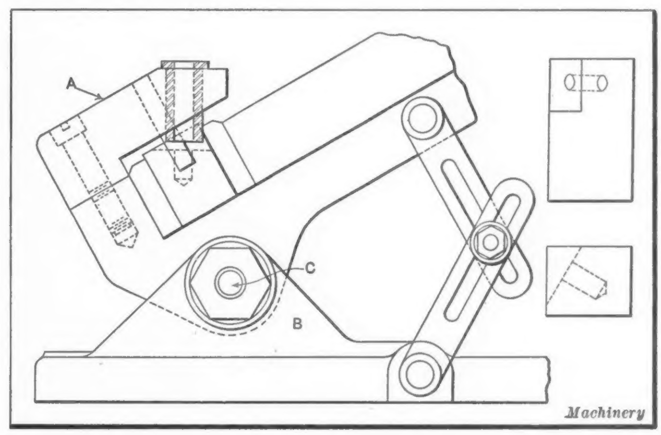


Fig. 18. Drilling on an Angle in Swivel Vise

Fig. 12, where it will be seen that a stop A may be used to locate the work while the bracket B holds the bushing which guides the drill.

As a simple illustration of the principle involved in using a jig of this type, reference is made to Fig. 14, in which the part being machined is a round collar. This collar A is gripped against a vee in the solid jaw, and the bracket containing the bushing B is adjusted to the correct position for guiding the drill into the work. It is clamped in place on the solid jaw by means of bolts C. To operate the jig, the movable jaw is opened and a piece of work inserted in the V-block.

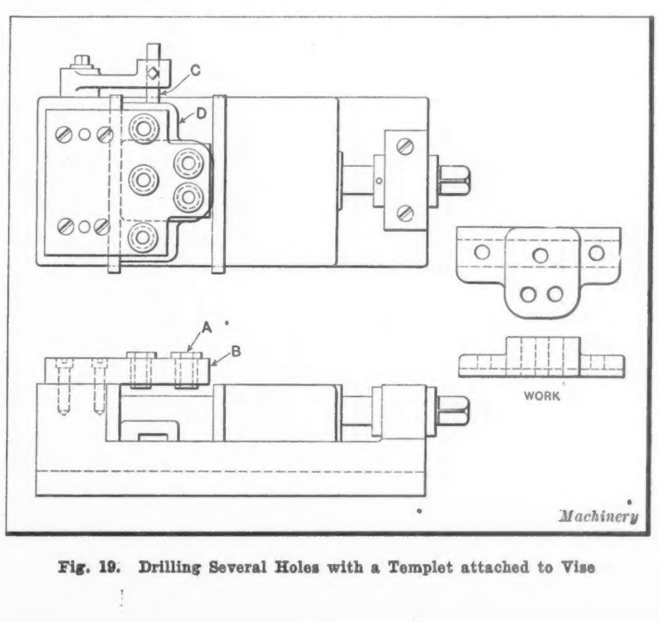


Fig. 19. Drilling Several Holes with a Templet attached to Vise

Then it is only necessary to tighten the jaws and proceed to drill. In this way, duplicate parts are obtained without an elaborate jig. By using suitable plates in these jigs, many odd-shaped pieces can be drilled, of which Fig. 19 is a typical example. The method of using this plate is obvious from the illustration. Bushings *A* are placed in the plate *B* at the proper location to guide the drills into the work. The plate is screwed on top of the vise, the stop *C* is adjusted to the proper location, and the work *D* placed in the vise against the stop, after which the holes are drilled.

This jig construction adapted to drilling holes on an angle is illustrated in Fig. 18. In this case, a swivel vise is fitted with a plate *A* set at the proper angle in relation to the base *B*. Then by swinging the vise up to the proper angle, the parts may be drilled in duplicate as in the previous case cited. That there are infinite possibilities in the fitting of vises with bushing plates when these are intelligently used, will be readily seen by considering the methods of drilling illustrated in Fig. 16. This illustrates a swivel vise used as an indexing jig, and where extreme speed or accuracy is not required it works out very satisfactorily. The first drilling is done with the vise in the position illustrated. The subsequent drilling is accomplished by tilting the swivel vise to the right and left the desired number of degrees.

Another example of drilling in a vise is shown in Fig. 15; here a number of holes are being drilled around a circle. This is accomplished by gripping the work between the jaws in the vise proper and having a bushing plate to set on pins *A* and *B* in the vise. By sliding the vise to various positions the holes are drilled in the usual manner. This bushing plate is removable for taking out the work. Besides the vises with jig attachments, there are a number of quick-operating vises, of which Fig. 17 is a standard model. This vise is operated by a handle *A* and toggle *B* which is suitable for short operations requiring quick releasing of the work, such as milling screw slots, short drilling, etc.

The vises here illustrated are not always the most economical means of handling work, but they are often the best that the extent of the job will warrant. They must not be confused with more elaborate jigs and fixtures which, although vises in principle, are special in construction. Not all shops can afford the costly design that the manufacture of guns or automobiles will warrant. They must compromise on the cheaper and less effective equipment that can be adapted quickly to a wide range of work, and the machine vise, as shown in the foregoing, can be made a universal fixture within its limits.

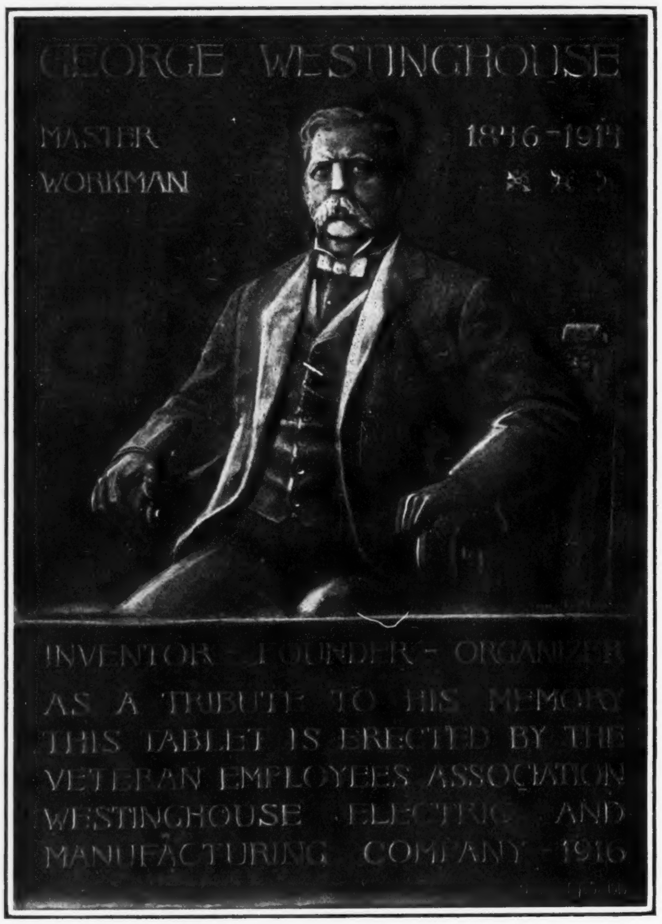
* * *

MAKING CAMS BY HYDRAULIC PRESSURE

A number of barrel cams which are required to be light and perfectly balanced are employed in a certain textile machine. An ingenious and effective method of making these cams has been worked out, which produces a cam with little machining, and one that is in perfect standing balance and in almost perfect dynamic balance. The method is substantially as follows: A hardened steel pattern of the desired cam is made in two parts, the parting line being along the middle or side of the cam groove. This two-part pattern or mandrel is placed within a section of seamless tubing of the required length to make the barrel cam. The mandrel fits the tubing closely and the ends are covered with rubber gaskets to prevent the ingress of water or other liquid under heavy pressure between the mandrel and the tube. The assembled tube and mandrel are then placed within a steel container and subjected to heavy hydraulic pressure—sufficient to draw the tube wall down in the cam path and form a perfect copy of the master cam. The mandrel and hydraulically formed cam are then removed, and heads are welded to the barrel by the oxy-acetylene process. As stated, the resulting cam is light, in balance, and is made with little machining except cutting off and boring holes in the heads for mounting on the shaft. It is an interesting example of the possibilities of hollow forming of sheet metal by hydraulic pressure. Hollow silverware has been made by hydraulic pressure for many years, rubber pads being used to form a convenient and adaptable hydraulic medium.

WESTINGHOUSE MEMORIAL TABLET

The Veteran Employes' Association of the Westinghouse Electric & Mfg. Co., at its third annual banquet held Saturday evening, January 29, in the Fort Pitt Hotel, Pittsburg, presented to the company a bronze memorial tablet of the late George Westinghouse, founder of the numerous industries bearing his name. About 450 veterans were present, and officers and men from the shop mingled freely and discussed old times when the electrical industry was in its infancy. The organization is composed of those who have been in the employ of the company for twenty years or more. The memorial tablet is about three by four feet, made of solid cast bronze, and weighs about 300 pounds. It shows a true bas-relief likeness of Mr. Westinghouse taken from one of his best photographic poses, and bears the inscription "George Westinghouse, Master Workman, Inventor, Founder, Organizer, 1846-1914." The tablet will be placed in the reception room of the East Pittsburg works of the company.



Westinghouse Memorial Tablet presented to the Westinghouse Electric & Mfg. Co. by the Veteran Employes' Association

* * *

MECHANICAL SUBJECTS AS SOMETIMES DESCRIBED

In a work on forging by an author who has published a number of mechanical books over his name, we find the following item, which we could not withhold from our readers:

Description of Hydraulic Press

For the benefit of those who are not familiar with a forging machine or press, a description of one will be given here. We will describe a large press. Most forgings made by pressing in shaped dies can be produced on a small press. The smaller the press used for accomplishing your work the greater the economy.

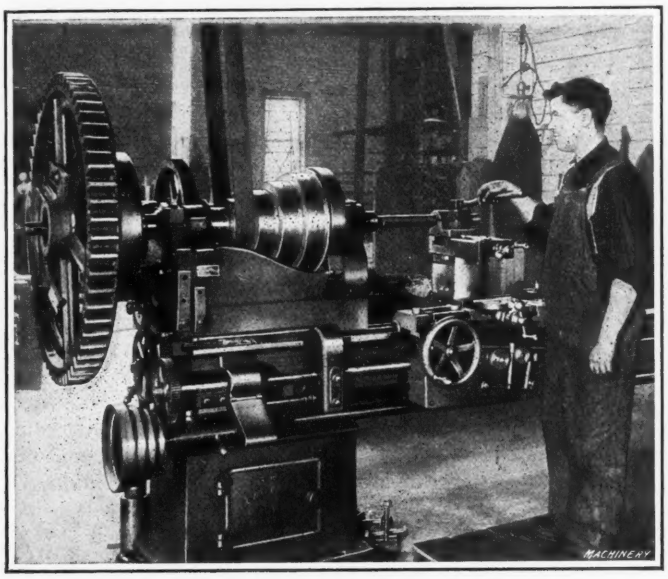
Embodied in the press proper is an operating plunger. This is pulled back after performing its stroke by a plunger. A platen is made movable to facilitate the handling of heavy dies. The dies are secured to the plunger and platen by means of bolts in tee slots. The press is usually operated by 500 pounds water pressure. When greater pressure is required an intensifier on the left of the press is used.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

BORING LARGE WORK ON A LATHE

Jobbing shops are frequently called upon to perform a boring operation on some part that is too large for the swing of any machine in the shop, and the following describes a method by which such parts can be handled on the lathe. The large gear shown in the illustration was the intermediate wheel on a steam tractor, and the bearing of this gear had become



Method of boring Work on Lathe, that is too Large for Swing of Machine

so badly worn that it had to be rebored. For handling such work we adopted the expedient of making a special faceplate and chuck, with a long hub on the faceplate bored to fit the rear end of the lathe spindle. This faceplate was secured to the spindle by means of set-screws carried in tapped holes in the hub. A special tool-block was made to hold the center of the boring-bar at the same height as the center of the spindle, and the bar was made long enough to reach through the spindle. To steady the bar while boring, a bushing was provided that was a tight fit in the spindle and a running fit on the bar. It will be evident that the cutter was located at the outer end of the bar, and provision was made for taking successive cuts by adjusting the tool. The regular longitudinal feed was employed to traverse the bar through the work.

Mankato, Minn. GEORGE WILSON

PRECISION GRINDING KINK

The following method will be found useful in handling toolroom work or any other class of work in which it is required to finish a piece perfectly square. The method is particularly applicable for sizing and finishing square or hexagonal broaches, plug gages, keyway gages and similar parts, where a high degree of accuracy is required. In order to explain the method of procedure, suppose that a square plug has been roughed out to within 0.005 inch on a universal grinder, using a dividing head for locating successive sides in relation to each other. After taking a cut 0.003 or 0.004 inch deep all around, the plug will show an error of from 0.00025 to 0.001 inch, no matter how carefully the work has been done.

If the variation is slight, an indicator may be employed to determine the amount of error. Suppose the error does not exceed 0.00025 inch. The plug should be ground to within 0.00075 inch of size, after which the following kink may be employed for the finishing operation. First, determine the high and low sides of the plug and then place it on a magnetic chuck on the surface grinder. Start with a cut about 0.00025 inch deep on the high side and run to within about 1/32 inch of the low side. Then turn the plug over so that the opposite side is at the top and the 1/32 inch of stock left on the first side will raise the low side an amount equal to the error. A cut is now taken right across the work, after which the plug is again turned over to enable a slight cut to be taken across the first side. The two opposite sides will now be found to be perfectly parallel with each other. The two remaining sides of the work are then treated in the same way.

This idea is far better than attempting to shim up the work, a method which is entirely impractical where the total error is not more than 0.005 inch. It will be evident that by the method which has been described, a part of the work becomes the shim and this part is sure to be free of inequalities in thickness which would affect the accuracy of the work produced. The method has been thoroughly tried out in the toolroom in which the writer is employed, and it has given very satisfactory results.

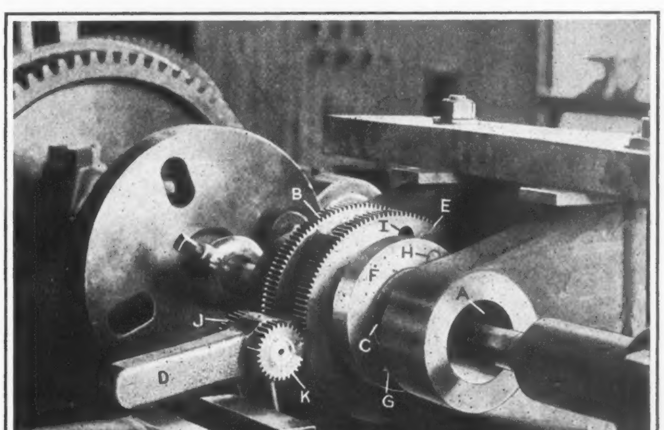
Plainfield, N. J. GUS ENGLER

AN UNUSUAL FACING DEVICE

The criticism is often made of manual training that the work is impractical and that it is only boy's play. The Stout Institute of Menomonie, Wis., works on the policy that the information a manual training school boy is given should be the same as that given to a vocational school boy or to an apprentice. The courses given to boys specializing in some particular branch of shop work are very practical. As an example of this, there is now being built by one group of boys, a couple of patternmaker's disk sanders. These machines were carefully designed and are being well built.

The equipment of the school does not include a boring machine, so it was necessary to bore the bearings of the main frame on the large lathe. The boring presented no especial difficulty, but the facing of the ends of the bearings was quite a problem. This was foreseen by the instructor and so the problem was presented to the class several weeks before the tools were needed. The various members of the class submitted solutions, many of which were impractical. After the design was agreed upon, the job was turned over to one Joe Prisk, who made the patterns and did the machine work.

The problem, simply stated, is to get a tool to travel across a radial face which must be truly flat and square with the



Facing Device developed to machine a Piece too Long to swing on the Lathe

axis of hole *A*. The accuracy required made it advisable to use a small pointed single tool. The lathe attachment shown in the accompanying illustration afforded a satisfactory solution of the problem. It consists of a differential gear and an eccentric. Gear *B* and eccentric *C* are secured to the shaft and lever *D* is a running fit on the shaft. Gear *E* is mounted

on a hub integral with lever *D*, and ring *F* is a working fit on eccentric *C* and carries tool *G*. Ring *F* is driven by the pin *H* which continues through gear *E* which is slotted at *I* to receive it. The gear must be slotted because in one position the pin is at the high side of the eccentric and at another it is at the low side. Lever *D* carries the two pinions *J* and *K* which are keyed to the shaft that carries them.

Gear *B* has 121 teeth and gear *E* has 120 teeth. Now as gear *B* is fixed to the shaft, it drives pinion *J*, meshing with it when the shaft is turned. This, in turn, drives pinion *K* on the opposite side of lever *D* and transmits motion to gear *E*. But the difference of one tooth causes gear *E* to gain one tooth during each revolution, thus causing ring *F* to slip ahead on eccentric *C* which is fixed to the shaft. If tool *G* is at the low side of the eccentric it will fall inside the hole. As ring *F* slips around eccentric *C*, tool *G* will move toward the high side of the eccentric, and in so doing will pass across the face of the casting. The attachment worked perfectly from the first and did not need any improvements to produce satisfactory results.

Menomonie, Wis. F. F. HILLIX

HOW WE MADE THE SWITCH PARTS

We were hard pushed with work in the press department last fall, and there was nothing to do but put some of the work out. So we picked out the parts we didn't have tools for, and sent them out to a lot of shops in that line of work to see what prices we could get. We found one place up the valley that made us an exceptionally good offer, and they had a name for doing good work, so we sent them quite a lot—mostly switch parts—and among these was a piece like that

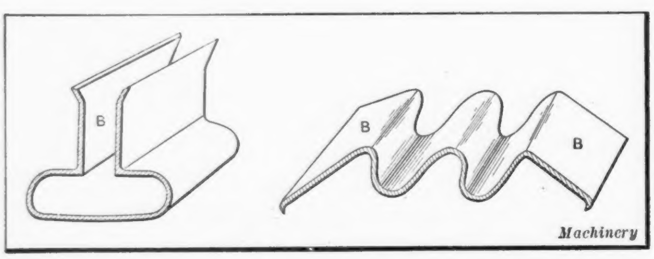


Fig. 1. Switch Part to be made Fig. 2. Blank produced by First Operation on Switch Part

shown in Fig. 1. It was not a hard piece to make—at least, we did not think so then—and the only difficult point was that the printed matter guaranteed 80 per cent contact at *B*, where the switch blade fitted in when the switch was closed.

They accepted the offer, made their own tools, and in due time the parts began to come back. They were fine. In fact, it was the best press work we had seen in a good while, even better than we were doing ourselves, and we claimed to do good work too. Well, they made the parts for nearly a year, and then we got over our rush. The original contract had long expired, so as fast as we could make the tools we took the work into our own shop, but when we came to the switch springs we seemed to be "up against it." We tried two or three ways to make them. First we tried to U them up and flatten the U, and then we tried a press with a side attachment that was used on other work of this kind, but in spite of all we could do, we could not get the 80 per cent contact on the side. It would come out nearer 8 than 80 per cent.

One day the "super" came along and saw what we were trying to do and said:

"Don't fool all your time away on those tools. I'll write up the valley and ask Brown how he makes them. In fact, I'll get him to send a sketch of the tools."

He wrote up, and got a nice letter back. They said they were glad we liked the punchings and were sorry we were going to make the parts ourselves, and while the contract called for making the punchings at such a price, they did not find anything in it about furnishing tools or information how to make them, and though they would be pleased to renew the contract they humbly begged to be excused from furnishing any sketches for tools. They said they did not know much about press tools anyhow. That put us in a hole; or rather it left us in the same cavity we were in before we wrote for the information.

Now, when Brown sent the work in, we used to check up the amount in the usual manner, by weighing the lot and counting out a pound to see if it was O. K. One day the girl who was doing this work said:

"Mr. Press, here are two pieces of work that look funny. I don't think they belong to us. Will I throw them out?"

She was talking to the "super," but the foreman of the toolroom happened to be passing at just that moment, and he grabbed the pieces as though they were made of gold instead of copper.

"Throw out nothing," said he, "pay for them; they are worth their weight in gold to us."

And as he turned to the "super," he said, "There it is, Mr. Press, right there. That's the first operation we've been trying so hard to get. We can make the switch parts without any trouble now, and save an operation in doing it, too."

As will be seen from Fig. 2, the principle employed in making the pieces was to use the whole power of the press on the contact surfaces, leaving them straight and true and just the shape desired.

We went ahead and finished the tools and are now making the parts, and poor Brown has really shown us how to do it, although he doesn't know it. A. P. PRESS

THE REAL PURPOSE OF A DRAWING

The real purpose of a drawing is often misunderstood by the mechanic who uses it. This is especially true in the development of new apparatus. The prevailing idea among mechanics is that the drawing should be correct in details and design. That is the designer's job, and if not correct, he is a "light weight" in the mechanic's opinion. This is the wrong viewpoint. Since it is utterly impossible to explain verbally or in writing what is wanted, the drawing acts as the most satisfactory medium of explanation. If verbal or written explanation were possible, there would be no need of designs and drawings except for the sake of record and duplication. It is impossible for the mechanic to view a new piece of apparatus in his mind as it will actually appear, from a description only, and it is the designer's duty to picture the apparatus on paper so that the mechanic can build it. Simplicity constitutes good design, and in order to obtain it frequent changes and improvements are necessary in building an apparatus.

The real purpose of the preliminary drawing is to give the mechanic the knowledge necessary to start work. If, in the mechanic's opinion, some improvements can be effected over the method shown on the drawing, his ideas should be advanced and considered. Many mechanics know that a design is wrong or could be improved upon but keep silent, delighting in "putting it over" on the designer by making the part wrong because it is shown wrong on the drawing. Eventually the designer or someone not directly connected with the work will see the error and receive credit for the improvement. There are instances where four, five or six machines are built before one is fully satisfactory, but each one develops improvements. A drawing was required to start the first one, so the real purpose of the drawing was to make the start. When the machine is satisfactory, the drawings are corrected for record and duplication. After the drawings are corrected, the mechanic may be justified in "knocking" the draftsman if he finds an error.

This misunderstanding of the purpose of a drawing is not always confined to mechanics, but extends even to some foremen. If they look forward to greater responsibilities, they should strive to improve and not condemn a poor design.

There is a somewhat similar weakness in some draftsmen—and incidentally they will remain draftsmen all their lives—who draw only that which is told them and nothing more. If they have any ideas of their own they should incorporate them in the design, even if they are not accepted. Whatever may have been put on the drawing leads to discussion, and discussion leads to other ideas, some of which may be utilized in the final design. The man in charge can explain changes in design more readily than he can furnish all the information necessary. In this case the purpose of the drawing is to de-

velop the imaginary ideas of the inventor or designer in their preliminary stages.

Watertown, Mass. W. J. Bitterlich

[The foregoing refers, of course, only to preliminary drawings of new mechanisms or machines. A drawing which is to furnish directions regarding the manufacture of a part of some standard machine such as an automobile or typewriter should contain specific information regarding size, finish, material, etc. There should not be the slightest doubt of the correctness of this information. It is generally accepted that data contained on drawings of this type should be infallible, the same as all other data that is supplied to a manufacturing department, such as instruction cards, etc. To furnish a manufacturing drawing that is not complete in every detail is a serious matter. The proper condition is for the drafting-room and planning department to cooperate in furnishing the shop or manufacturing department with all the drawings, orders and various other information necessary to produce a part that must be interchangeable.

In the development of a new mechanism on the drawing-board, however, there is a definite limit to the ideas that can be laid out in the drawing. After a design has been carried so far on a drawing-board, it is absolutely essential that a model be made. The making of this model will no doubt bring out ideas that will make it advisable to redesign the mechanism on the drawing-board. Thus it is essential that the closest cooperation exist between the makers of the experimental mechanism and the engineering department. The value of cooperation cannot be over-emphasized by the management. Also, no pains should be spared to acknowledge the value of an idea submitted by a subordinate. The overlooking of this point has killed originality in many a young man.—Editor.]

MACHINING ANGULAR SURFACES

One of the most common complaints which the machinist makes about the draftsman's work is that he has failed to give complete dimensions for angular surfaces which have to be machined. As a result, the machinist is required to do a certain amount of figuring for himself, and as this is work with which he may not be thoroughly familiar, he may make a mistake. It is my purpose to describe a method of machining such surfaces, in which the machine is required to make the calculations, and this will doubtless prove of interest to machinists who are not thoroughly grounded in mathematics.

Fig. 1 shows part of an angular sided groove in a circular cutter, the drawing for which was dimensioned as shown. As the inner corners of such grooves are generally filleted it is not possible to start the angular cut at the bottom of the groove and work out—a method which would result in determining the width *AD* by setting over the compound slide to an angle of 2 degrees, 30 minutes. But with a filleted groove of the form shown, it is necessary to set over the compound rest to the required angle and start the cut at the top of the groove, as shown in Fig. 2.

The method of procedure is as follows: With the compound rest set at an angle of 2 degrees, 30 minutes, in the proper direction for cutting the right-hand side of the groove, the tool is made to touch corner *A*; and with the carriage and cross-feed locked the tool will traverse along line *AG* when moved by the compound slide. But if, when the cutting point of the tool is just touching corner *A*, it is first traversed back along line *GH* for a distance slightly in excess of 0.375 inch and then traversed forward 0.375 inch by the cross-feed slide, the cutting point of the tool will lie on line *IF* which is a continuation of surface *FB* which it is required to machine. Should it happen that the wedge shaped piece *ABF* is too large to be removed by a single cut, it may be divided into as many cuts as required by feeding the cross-slide forward through any suitable portion of the total 0.375 inch before starting to take each cut.

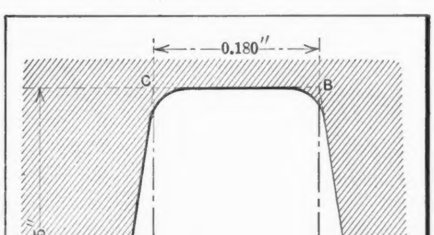


Fig. 1. The Way in which Dimensions were given

Should it happen that corner *A* is not perfect, a trial cut may be taken, after which the distance of the point from the outside of the work may be measured; the cross-feed slide is then fed up the remainder of the 0.375 inch, after which a finishing cut is taken. In doing work of this kind it will be found advisable to leave a light finishing cut to be taken over the outside of the work after the angular surfaces have been machined. When this practice is followed, the finishing cut will decrease the depth of the groove. It will be readily seen that the method described can be applied to any form of angular or taper work.

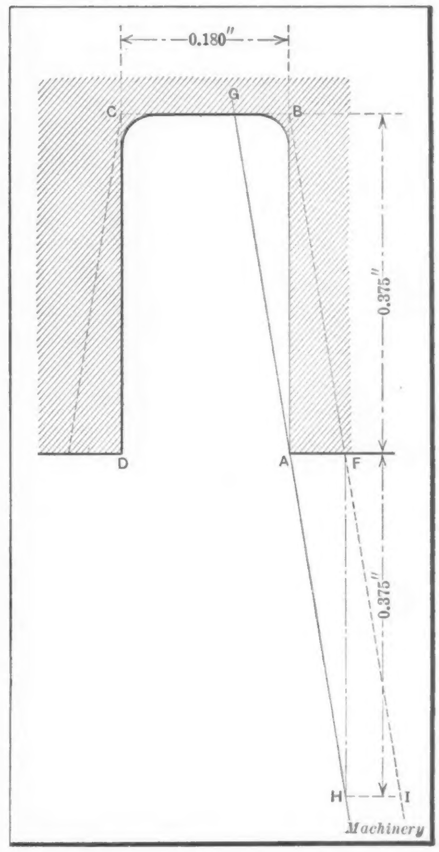


Fig. 2. Method of doing Work by which Dimensions are determined by Machine

Wilkinsburg, Pa. William S. Rowell

DRILLING PIN HOLES FOR DRIVING FIT

When it is required to drill holes of such a size that pins inserted in them will have a driving fit, the following method will give satisfactory results. Each hole is first drilled with a drill one size smaller than the stock from which the pin is made. A drill of the same size as the stock is then mounted in the drill spindle and the lever feed is employed to feed the drill through the work as rapidly as possible. The faster the drill is fed, the smaller will be the size of the hole, and hence the tighter the fit of the pin.

Wausaukee, Wis. W. E. Butler

BABBITT BEARING MOLD

In the October number of Machinery, a description was published of a babbitt bearing mold which was claimed to be more efficient and longer-lived than the mold I described in the March number. In view of the fact that I am concerned with the babbitting of bearings and similar work almost every day, I feel justified in offering a few criticisms—not because the design referred to differs from my own, but because some of its shortcomings are too serious to pass unnoticed.

In the first place, the mold sections are held together by a spring extending across pins that are located so close to the hinge that only a small leverage is provided. Furthermore, any slight wear in the hinge, which is practically bound to occur, will result in throwing the molds out of alignment. Another difficulty is likely to result from the fact that the high temperature of the mold will be likely to affect the tension of the spring and allow the mold to open enough to cause leakage between the core and mold sections. Even if the spring is in good condition, sticking of the mold will often cause leakage and the metal will overflow into the hinge and cause trouble. Unless the molds are absolutely tight and always kept accurate, the wall of the bearing will not be uniform.

After casting a bearing liner in this mold, a center piece is driven up with a hammer in order to cut off the gate or sprue. In the writer's opinion an operation of this kind, performed while the bearing is still hot, will be almost sure to cause serious distortion. But probably the most serious defect of the mold is the fact that no provision appears to have been made for allowing the air to escape, and such provision is more necessary in a steel mold than in a sand mold. The casting is also gated at the top, which would increase the probability of trapping the air in the mold. After noticing these defects, I fail to see the justification for the claim that this mold is more efficient than the one described in the March number of MACHINERY. S. SUCRAM

DRYING AIR FOR THE SAND BLAST

On damp days we experienced trouble from the moisture in compressed air causing the sand to clog in the nozzles of our sand blasts, and at times from one-third to one-fourth of the operator's time would be occupied in endeavoring to clear away the obstruction. Several ways were suggested for drying the air, such as using a filter composed of pebbles and spongy material or passing the air through calcium chloride which is successfully used as a laboratory drying agent. The method which finally offered a solution of the problem consisted of placing gas burners beneath the main air pipe leading to the sand blasts, and since this plan was put into operation we have had absolutely no trouble from moist sand causing the apparatus to clog.

The reason is quite simple. When moist air is compressed its volume is reduced, but the moisture remains the same. As the air leaves the compressor and passes into the air tank, it cools and allows some of the excess moisture to drop to the bottom of the tank where it causes no further trouble; but the air as it leaves the compressor tank continues to cool and lose moisture. If, on the other hand, the air is heated just before it goes to the sand blast, the moisture is retained and the air is said to be "dry." Only a small flame is required to heat the air, as a few degrees rise in temperature accomplishes the desired result. The same method may be employed in all processes using compressed air, where the presence of much moisture in the air is found to be objectionable.

Kenmore, N. Y. GEORGE B. MORRIS

APPLICATION OF DOUBLE WEDGE TO DIE WORK

In designing special fixtures for punch press work, it frequently happens that some part of the fixture must travel in a horizontal plane while the ram of the press moves in a vertical plane. In cases of this kind, it is customary to fasten a cam directly to the punch-block or holder, as shown in Fig. 1. *Y* indicates the vertical travel of the ram, causing the slide *A* to move through the distance *X*. As long as the distance *X* is the same or smaller than *Y*, no particular trouble will be encountered, but with a reversal of conditions, difficulties are experienced. The angle *P* should not exceed 40 to 45 degrees. If the power necessary to move the slide *A* is excessive, a small angle at *P* would be necessary. This small angle of necessity limits the length of the travel of the part *A*. If the travel of the slide *A* is considerable, some modified cam principle must be used.

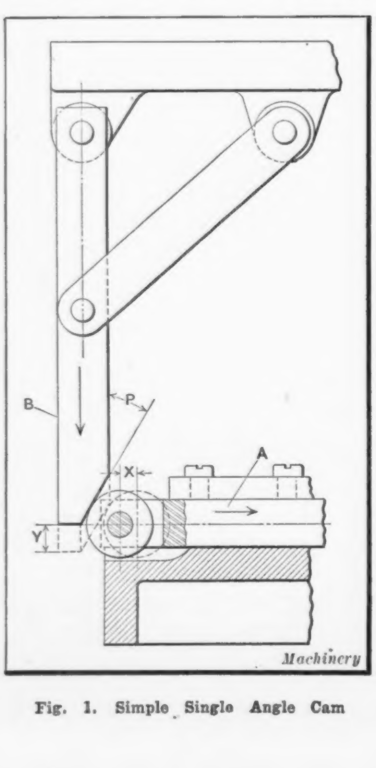


Fig. 1. Simple Single Angle Cam

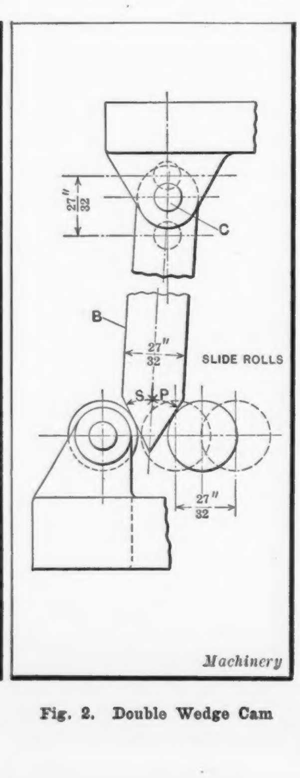


Fig. 2. Double Wedge Cam

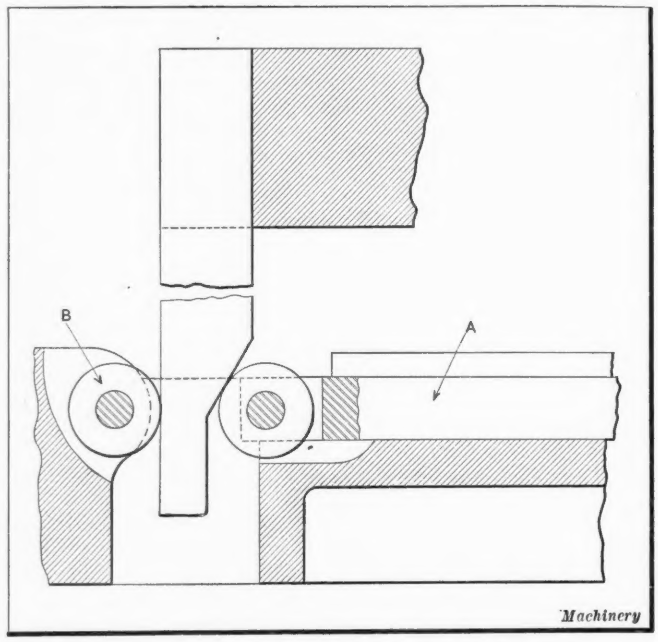


Fig. 3. Single Angle Cam with Roll for taking Thrust

A simple modification is suggested in Fig. 2. The cam *B* instead of being firmly attached to the punch-holder is free to rock about the pin *C*. The working end has a double taper, one side bearing on a roll in the slide and the other against a stationary roll on the fixture. In this instance, the angles *S* and *P* are each equal to 30 degrees, and the slide moves 27/32 inch forward while the cam descends the same distance.

It will be seen that by this device the downward component of the pressure on the slide may be kept quite small; furthermore, the resistance offered to the slide produces internal stresses within the base instead of making a cantilever of the cam *B*, as in Fig. 1.

Flint, Mich. M. TERRY

[An improvement over the method shown in Fig. 1 is shown in Fig. 3. Here, instead of the thrust of the slide being taken by the cam as in Fig. 1, it is taken by the roll *B*, which is mounted in the die.—EDITOR.]

DRILLING SMALL HOLES STRAIGHT

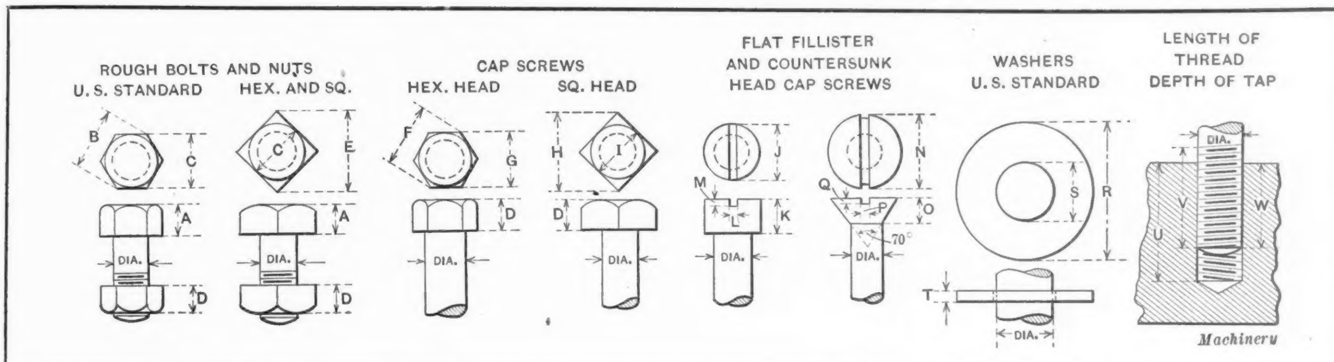
When it is required to drill deep holes with a small drill of some such size as No. 30, it is not an easy matter to keep the holes straight. The first step is to grind the drill carefully. The work is then clamped to the faceplate of a lathe, using a center indicator to locate it in the desired position. The drill is then mounted in a drill chuck and the chuck placed in the tailstock, but left loose so that it may be turned from time to time. After drilling to a depth of from 1/16 to 1/8 inch, the drill chuck is turned from one-quarter to one-half revolution, so that all the cutting will not be done with the drill in the same position. By turning the chuck in this way at intervals of about 1/8 inch, holes as deep as 3 inches may be drilled perfectly straight.

Wausaukee, Wis. W. E. BUTLER

MARKING SCALES ON DRAWINGS

Here is a suggestion for draftsmen when marking the scales of drawings. Instead of marking the drawing scale one-half size, or twice the actual size, make a large S, and in the upper

TABLE OF CONDENSED SCREW DATA



Dia.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1/8	..	..	..	..	..	..	..	..	..	3/16	1/8	0.032	1/16	1/4	3/32	0.040	3/64	..	..	..	..	..	..
3/16	..	..	..	..	..	..	..	..	..	1/4	3/16	0.040	1/16	3/8	9/64	0.064	3/64	9/16	1/4	3/64	..	..	..
1/4	1/4	37/64	1/2	1/4	23/32	1/2	7/16	17/32	3/8	3/8	1/4	0.064	1/16	15/32	5/32	0.072	1/16	3/4	5/16	1/16	..	..	..
5/16	19/64	11/16	19/32	5/16	27/32	37/64	1/2	5/8	7/16	7/16	5/16	0.072	5/64	5/8	7/32	0.102	5/64	7/8	3/8	1/16	..	..	..
3/8	11/32	51/64	11/16	3/8	31/32	21/32	9/16	45/64	1/2	9/16	3/8	0.091	3/32	3/4	17/64	0.114	3/32	1	7/16	5/64	..	..	..
7/16	25/64	29/32	25/32	7/16	1 7/64	23/32	5/8	51/64	9/16	5/8	7/16	0.102	7/64	13/16	17/64	0.114	3/32	1 1/4	1/2	5/64	..	..	..
1/2	7/16	1 1/64	7/8	1/2	1 1/4	7/8	3/4	57/64	5/8	3/4	1/2	0.114	1/8	7/8	17/64	0.128	3/32	1 3/8	9/16	3/32	1	7/8	3/4
9/16	31/64	1 1/8	31/32	9/16	1 3/8	15/16	13/16	31/32	11/16	13/16	9/16	0.114	9/64	1	5/16	0.133	7/64	1 1/2	5/8	3/32	1 1/16	..	..
5/8	17/32	1 15/64	1 1/16	5/8	1 1/2	1 1/64	7/8	1 1/16	3/4	7/8	5/8	0.128	5/32	1 1/8	23/64	0.133	1/8	1 3/4	11/16	1/8	1 1/8	1	7/8
3/4	5/8	1 29/64	1 1/4	3/4	1 25/32	1 5/32	1	1 15/64	7/8	1	3/4	0.133	3/16	1 3/8	7/16	0.133	5/32	2	13/16	1/8	1 3/8	1 1/8	1
7/8	23/32	1 43/64	1 7/16	7/8	2 1/32	1 19/64	1 1/8	1 19/32	1 1/8	1 1/8	7/8	0.133	7/32	..	..	.....	..	2 1/4	15/16	5/32	1 5/8	1 3/8	1 1/8
1	13/16	1 7/8	1 5/8	1	2 19/64	1 7/16	1 1/4	1 49/64	1 1/4	1 1/4	1	0.165	1/4	..	..	.....	..	2 1/2	1 1/16	5/32	1 3/4	1 1/2	1 1/4

Machinery

loop put the numerator, and in the lower loop the denominator of the fraction indicating the scale. Thus in one-half scale, it would be indicated by a large S in which 1 would appear in the upper loop and 2 in the lower loop. In the same way if the scale were twice normal size, the 2 would appear in the upper loop and the 1 in the lower loop. By the same rule, 1 would appear in the upper loop of the S and 1 in the lower loop also when the drawing is full size, or 1 to 1.

Prince Bay, S. I., N. Y. WILLIAM H. DAVID

CONDENSED SCREW DATA

The table given herewith is of interest only because of the condensed manner in which the data is presented. The information is not new, but was gathered from different parts of standard handbooks and made into one table. The designer who wishes to obtain the dimensions on bolts, cap-screws, flat and fillister head screws, washers, and depth of tapped holes, may get this information quickly by referring to the table.

Cleveland, Ohio. L. J. HENGESBACH

BOOKS ON SCIENTIFIC MANAGEMENT*

The editor of MACHINERY receives many inquiries relating to books on various subjects, and is often requested to recommend the best works dealing with the different phases of management and engineering. These requests indicate that many more readers are interested in the literature of management and kindred topics, and it is believed that the following list of books, which are conceded to be authoritative, will be appreciated by a wide circle of readers.

* The books given in the accompanying list are not published by the Industrial Press, but the names of the publishers will be furnished on request, or copies will be sent postpaid on receipt of price.

Applied Method of Scientific Management. By F. A. Parkhurst. 325 pages, 6 by 9 inches. Price, $2.

This book gives a description, in complete detail, of the methods of scientific management installed at the works of the Ferracute Machine Co. As regards details of scientific management, it is unusually complete.

Cost Keeping and Scientific Management. By H. A. Evans. 252 pages, 6 by 9 inches. Price, $3.

This is a practical treatise especially applied to machine shop work, describing the author's methods as applied at the Mare Island Navy Yard. It shows what may be done in installing scientific management by a competent manager, without the aid of experts.

Factory Organization and Administration. By Hugo Diemer. 380 pages, 6 by 9 inches. Price, $3.

This is an unusually complete book covering the details of organization and administration, from factory location and building, through departmental organization and relation, to cost and wage systems.

Industrial Plants. By Charles Day. 294 pages, 5 by 7½ inches. Price, $3.

This book contains instances of the application of some of the principles of scientific management to the design and construction of industrial plants. The book is recommended as a reliable guide in modern plant construction.

Installing Efficiency Methods. By C. E. Knoeppel. 260 pages, 7 by 10 inches. Price, $3.

This book explains step by step the method used for attaining greater output at lower cost, and contains descriptions of practice as distinct from a mere declaration of principles. The book undertakes to answer the questions which any one planning to install scientific management would naturally ask.

Maximum Production. By C. E. Knoeppel. 365 pages, 5 by 7½ inches. Price, $2.50.

In this book the machine shop and foundry are considered as twin factors in production, and the principles of scientific management are explained in their application, first to the shop and then to the foundry.

Motion Study. By F. B. Gilbreth. 116 pages, 5¼ by 8 inches. Price, $2.

This is a valuable study of the various factors involved in the performance of manual labor, and is illustrated with photographs and tables showing the author's methods and results in studying workman's motions in the brick-laying trade. It is highly recommended for students of the details of time and motion study.

Primer of Scientific Management. By Frank B. Gilbreth. 108 pages, 5¼ by 8 inches. Price, $1.

This is an elementary, popularly written presentation of the fundamental principles of scientific management, explaining the Taylor system and answering some of the criticisms raised against it.

Principles of Industrial Organization. By Dexter S. Kimball. 300 pages, 6 by 9 inches. Price, $2.50.

This book does not explain any special form of industrial management, nor does it undertake to give complete details, but it contains a careful analysis of the principles underlying the problem of industrial organization.

Principles of Scientific Management. By F. W. Taylor. 144 pages, 6 by 9 inches. Price, $1.50.

This is a popular restatement of the principles of scientific management, as made by the author after his retirement from active practice. It deals with the principles in a more general way than in the author's "Shop Management."

Production Factors. By A. Hamilton Church. 200 pages, 5 by 7½ inches. Price, $2.

This book deals with the proper distribution of the expense burden in manufacturing, and relates especially to the cost system and the work of the cost accountant.

Science and Practice of Management. By A. Hamilton Church. 535 pages, 5 by 7½ inches. Price, $2.

This book contains a general analysis of the factors involved in industrial management, the purpose being to ascertain the fundamental factors influencing production, not from the viewpoint of cost, but of management.

Scientific Management. By C. B. Thompson. 878 pages, 6 by 9 inches. Price, $4.

This is a collection of articles published in the engineering press and papers presented before engineering societies, dealing with the various phases of scientific management. The work gives a clear and complete survey of the subject of scientific management.

Shop Management. By F. W. Taylor. 144 pages, 6 by 9 inches. Price, $1.50.

This was the first important contribution to the subject of scientific management, and comprises a summary of Taylor's theories. The book is a reprint of the paper delivered by Mr. Taylor before the June, 1903, meeting of the American Society of Mechanical Engineers.

Twelve Principles of Efficiency. By Harrington Emerson. 423 pages, 5 by 7½ inches. Price, $2.

This book deals with the philosophy of scientific management, dividing the subject into twelve principal parts, five of which concern the relations between employer and employe, and seven, industrial methods in the works.

Work, Wages and Profit. By H. L. Gantt. 312 pages, 5 by 7½ inches. Price, $2.

The main principles of the application of scientific management to industrial work are dealt with in this book, the essential factors involved in the system being explained without going into minute details as to how the system is applied in any specific case. It is a "classic" on general principles.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

CADILLAC SCREW THREAD

C. M. C.—What is the Cadillac screw thread?

A.—The Cadillac screw thread is the thread used by the Cadillac Motor Car Co., Detroit, Mich. It differs from the U. S. standard thread in that, while the sides are inclined to each other 60 degrees and it has a flat top, the bottom or root of the thread is a sharp V. Thus it partakes of the characteristics of both the U. S. standard thread and the sharp V-thread. In this respect, the Cadillac thread is like the International metric thread. The specifications for the International metric thread leave the shape of the root of the thread to the discretion of the user. It may be a sharp V and have a rounded fillet, or flat top, so long as the depth is sufficient to clear the tops of the thread in the nut.

KEROSENE IN BEARINGS

W. E. R.—I would like to have your opinion on the use of kerosene oil in bearings. "A" claims that putting kerosene in the bearings of a machine is beneficial, as it removes the gum and worn-out oil, while "B" claims that kerosene is necessarily injurious, because it dissolves rust and therefore it might dissolve the metal of the bearings.

A.—Kerosene oil has little or no lubricating property, but its use in bearings to remove gum and worn-out oil is an excellent practice provided it is flushed out with a liberal application of lubricating oil so that the bearings are left in a well lubricated condition to start. The fact that kerosene dissolves rust is no indication whatsoever that it would dissolve metal; as a matter of fact, it has little or no deteriorating effect on steel, brass, bronze or iron.

REMOVING SCALE FROM SHRAPNEL FORGINGS

C. C. N.—We would appreciate information on the following questions in connection with the pickling of forgings for three-inch Russian shrapnel. Would the method of pickling be the same for a shell that has been rough-turned from soft forging and then heat-treated, the remainder of the machining operations having been performed on the oil-tempered forging, as for an oil-tempered forging on which the machining operations have been performed so that no heat-treatment is necessary? Is a ten per cent solution of sulphuric acid in water most satisfactory for pickling? If not, what per cent of acid is recommended? At what temperature should the solution be maintained for the most effective removal of the scale? How long should the forging be submerged in the pickling solution? When neutralizing the acid, should a hot soda solution bath be used followed by a second washing in hot water, or is the soda solution bath sufficient? Has experience shown that pickling will entirely loosen the scale, or is it necessary to tumble the shells to knock the scale off during pickling or after pickling?

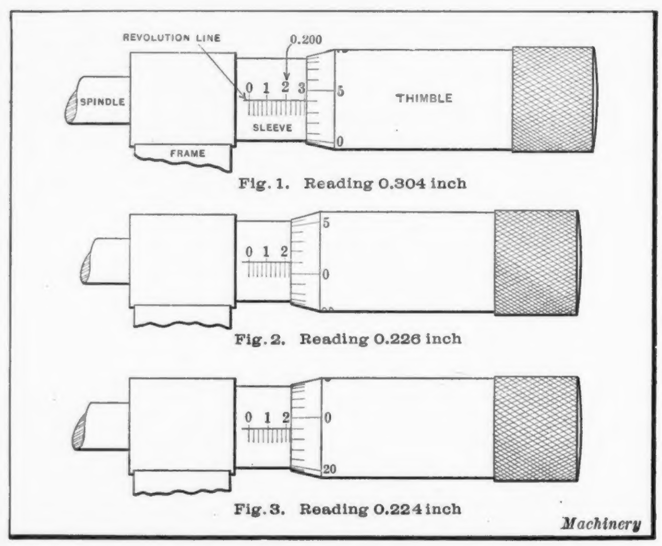
A.—The accepted method of manufacturing shrapnel shells is to perform the preliminary operations before heat-treating; then to heat-treat the shell and close in the nose. After that, the second series of operations is performed. Some manufacturers are machining shrapnel shell forgings without pickling, but unless the forgings are quite free from scale, this is not advisable. Very few, if any, manufacturers are pickling the shrapnel shells after heat-treatment. The scale is removed by sand-blasting only at the base end in order to take the scleroscope reading. Of course, the shells are either turned or ground after heat-treatment and scale is seldom objectionable for either of these machining operations. For cleaning forgings, a ten per cent sulphuric acid pickling solution is sufficient, and its temperature should never be above 150 degrees F. A high temperature of the pickling solution is objectionable because of the noxious fumes that are given off. The forging should remain in the pickling solution for forty-five to sixty minutes, depending on the size and the amount of scale to be removed. The best method of neutralizing the acid is to wash the forgings in a solution of hot limewater, then in either hot water or running cold water. Both methods are employed, but the use of hot water is preferable. There is a difference of opinion as regards results of pickling. The French government specifies that its high-explosive shells shall be wire-brushed following heat-treatment to remove all the scale, but one manufacturer making French shells has found that this operation is unnecessary and that pickling the forgings in a ten per cent solution for one hour removes all scale.

HOW TO READ A MICROMETER

A. L. M.—Will you please publish plain instructions for reading the micrometer? I do not understand the principle on which it operates.

Answered by J. T. Slocomb, Providence, R. I.

The micrometer divides the inch into one thousand parts. As usually made it has a 40 pitch screw which advances though its nut 0.025 inch per revolution. It is evident that if the measurements to be made were 0.025 inch or less, the graduations on the end of the revolving thimble, and the indicating or datum line on the stationary part would be sufficient. But to measure a greater range, it is necessary to have some means of counting and adding together the additional revolutions of the screw. This is accomplished in an ingenious and simple manner by the graduating and numbering used, and is plainly shown in the accompanying illustration. The cross lines on the sleeve are spaced 0.025 inch apart—a distance equal to the pitch of the screw. A revolution line is cut lengthways of the



How to read a Micrometer

sleeve which, in connection with the zero line on the thimble, records whole revolutions of the screw. When the end of the thimble matches any one of the cross lines and the zero line matches with the revolution line, the number of spaces exposed denotes the number of revolutions made. Every fourth cross line is numbered from 0 to 10. In Fig. 1 the reading is 0.304 inch, showing 0.300 inch on the sleeve and 0.004 inch on the thimble. In Fig. 2 the reading is 0.226, showing 0.225 inch on the sleeve and 0.001 inch on the thimble. In Fig. 3 the reading is 0.224 inch, showing 0.200 inch on the sleeve and 0.024 inch on the thimble. The figures should be taken off the sleeve as hundreds, that is, 100, 200, 300, etc. The thimble is shown purposely close to the lines in the illustration, as these are the points where a mistake is most likely to be made. In the 0.226 reading, the end of the thimble appears to match the cross lines nearly, but it is evident that it really does not, for the reason that the zero lines on the thimble and sleeve do not coincide but are one space advanced, which, of course, we add to the 0.225 making the reading 0.226 inches. The same is true in the 0.224 reading, but the zero line has gone by one space, making the reading 0.224.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

DIAMOND RIFLE BARREL AND RECEIVER DRILLING MACHINES

It will be seen that these machines provide for drilling two rifle barrels or two rifle receivers simultaneously. They are duplex machines in every sense of the word, being provided with two heads for driving the work, two tailstocks for holding the drills, and independent feed mechanisms and oil pumps for delivering lubricant to the work through the hollow drills. Connection between the pumps and tailstocks is made by telescopic tubes which adjust themselves to the constantly changing positions of the carriages as the drills are fed into the work. The design of these machines, as well as of the reaming and rifling machines described on the following pages, follows established practice for machines of these types, but the present activity in munitions manufacture makes them of peculiar interest. The manufacture of these machines has only recently been taken up by the Diamond Machine Co.

it is necessary to back the drill out at frequent intervals in order to clear the chips, is the fact that the operation is continuous. This has been made possible by constructing a special type of drill which is made hollow so that a copious flow of cutting compound may be delivered right to the point of the drill where it is most effective in dissipating the heat of the cut, and which has a groove down the side through which the oil escapes, washing away the chips as fast as they are produced.

The drill is made of sufficient length to extend entirely through the rifle barrel. The body of the drill is made of steel tubing which is rolled in at one side in order to produce the groove which provides for the escape of oil and chips from the work. The point of the drill is made of drill rod, and, as previously mentioned, there is a hole which provides

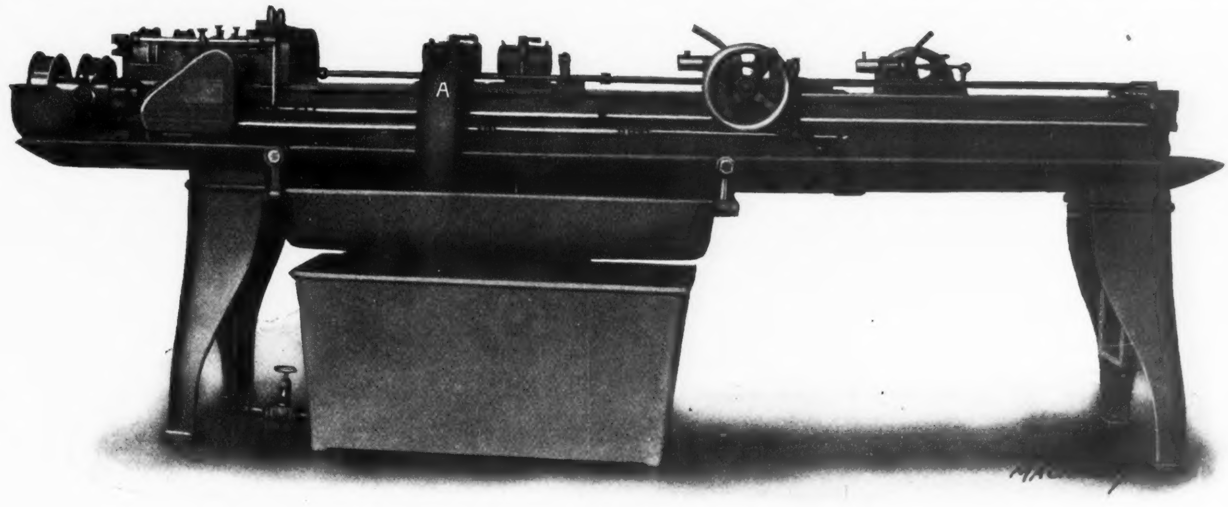


Fig. 1. Rifle Barrel Drilling Machine built by the Diamond Machine Co.

Any machinist who has had experience in the drilling of deep holes will appreciate the difficulties encountered in drilling a hole through steel rifle barrels 30 inches in length and maintaining an extremely high degree of accuracy in the work. But the study which has been made of the method of doing this work by the Diamond Machine Co., Providence, R. I., has resulted in the production of machines and drills capable of giving extremely satisfactory results. The most noteworthy feature of the operation to the mechanic who has had experience in drilling deep holes with ordinary drills, where

for the delivery of oil direct to the point. A groove is ground down the side of the drill in order to continue the groove which has been rolled in the steel tube; and the drill point is soldered to the end of the tube. The description will be better understood by referring to Fig. 4 which shows one of the drills.

It will be seen that the drilling machine provides for working on two rifle barrels at a time. The barrel forging is supported in a chuck in the headstock spindle, this chuck consisting of a tapered socket which is serrated so that a firm

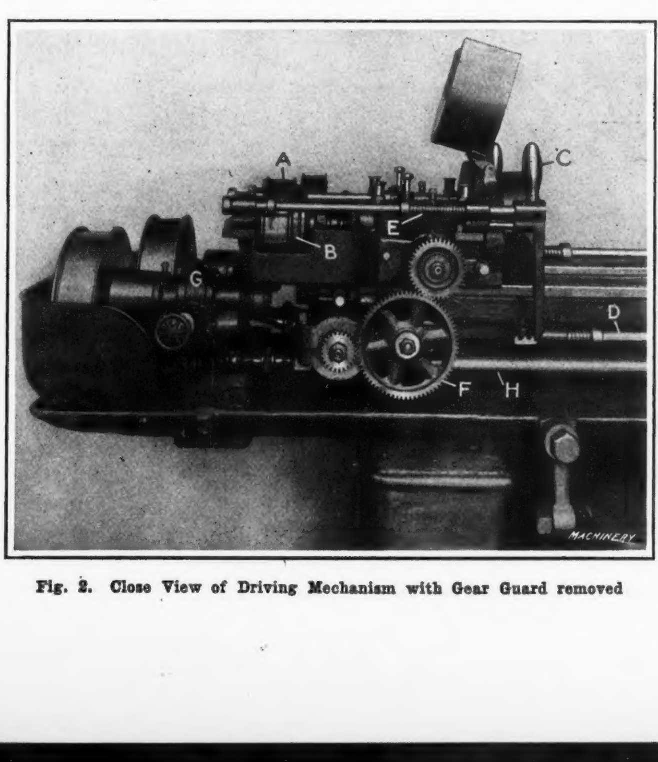


Fig. 2. Close View of Driving Mechanism with Gear Guard removed

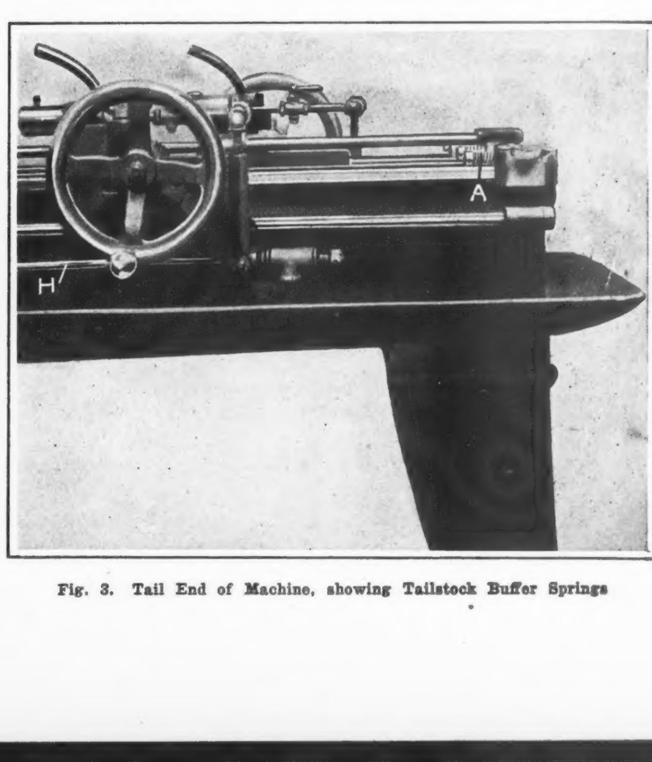


Fig. 3. Tail End of Machine, showing Tailstock Buffer Springs

grip is secured on the work when the end of the forging is driven into place by tapping the opposite end of the barrel with a lead hammer. The outer end of the work is supported by a bushing at the left-hand side of rest A, and at the right-hand side of this rest there is a guide bushing which is a close fit around the point of the drill. The work rotates and the drill is fed to the work by traversing the tailstock in which the shank of the drill is supported. As the drills are long and thin, it will be evident that some intermediate support is necessary, and this support is afforded by means of a steadyrest. This description and that which follows apply to one side of the machine, but it will be evident that the entire machine is composed of two sets of mechanism like that described.

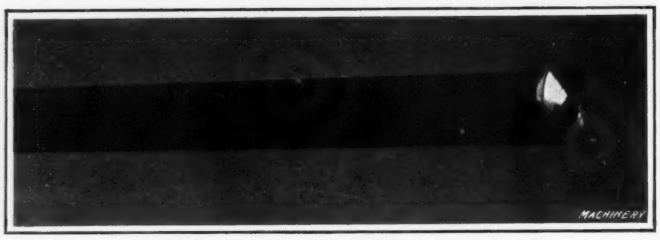


Fig. 4. Cutting End of a Rifle Barrel Drill

The arrangement of the drive will be best understood by referring to Fig. 2 which shows the mechanism quite clearly, but in connection with this description it should be understood that guards are provided over all gearing on the machine. The drill at the front of the machine is driven by pulley A which is mounted at the back of the spindle, and the power is transmitted through a friction clutch B which is held in engagement by the pointed end of lever C that engages a shoulder at the end of the horizontal rod D. But when the tailstock has been traversed far enough along the bed of the machine so that the hole has been drilled entirely through the rifle barrel, a dog on the tailstock engages an adjustable stop carried by rod D, with the result that this rod is rocked down so that the shoulder disengages the end of lever C. As a result, compression spring E becomes effective and throws clutch B out of engagement, thus stopping both the rotation of the spindle and the feeding of the drill to the work. The feed motion for the tailstock is transmitted from the spindle through a worm and wheel, change-gears F, and a second worm and wheel to a lead-screw located inside the bed of the machine. This lead-screw traverses the tailstock in the same way that the lead-screw of an ordinary engine lathe moves the carriage along the bed of the machine.

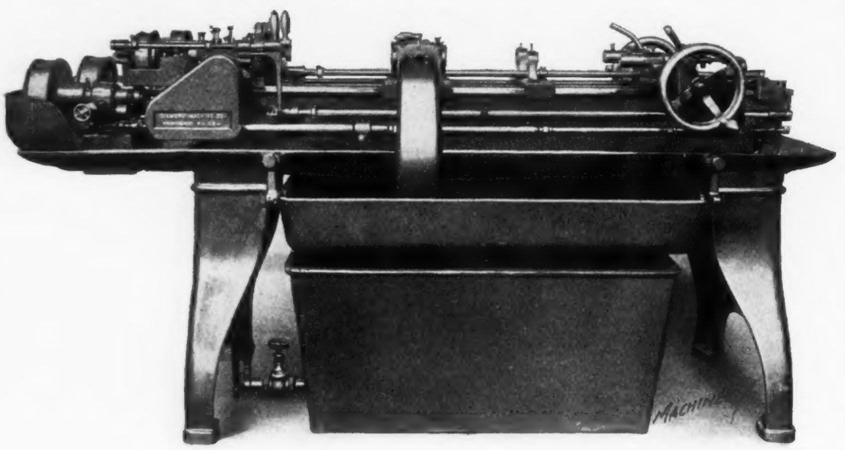


Fig. 5. Diamond Rifle Receiver Drilling Machine

In connection with the description of the drill it was mentioned that means are provided for clearing the chips from the hole by delivering a flow of oil through a tube in the drill and allowing it to escape by way of a groove at the side. The oil employed for this purpose is contained in a reservoir located beneath the machine, and the pump which is connected with this reservoir is shown at G, this pump being driven by a large pulley at the left-hand end of the machine. In order to provide for supplying the hollow drill with oil as the tailstock is traversed along the bed of the machine, connection is made with the tailstock and end of the hollow drill by means of a telescopic tube H through which oil is pumped from the reservoir. In order to secure satisfactory results in clearing the chips from the hole, it is necessary to have the oil at a pressure of not less than 800 pounds per square inch, and under actual working conditions this pressure is generally quite close to 1000 pounds per square inch. It will be evident that this pressure resists the action of the lead-screw in traversing the tailstock along the bed, and results in a tendency for the tailstock to move over toward the right-hand end of the bed.

After the drilling operation has been completed, the split nut by which connection is made between the lead-screw and tailstock is released in order to move the tailstock back to the starting position. Evidently when the split nut is released in this way there is a possibility of the residual pressure in the oil tube causing the tailstock to be thrown back with considerable force, and cases are on record where a machine has actually been wrecked in this way. To obviate trouble from this source, a buffer spring is provided as shown at A, Fig. 3, which will absorb the shock in case the tailstock is thrown back in this way. It will be evident that with oil at a pressure exceeding 800 pounds per square inch, it is necessary to provide an effective form of guard to prevent it from being thrown from the point at which it escapes from the end of

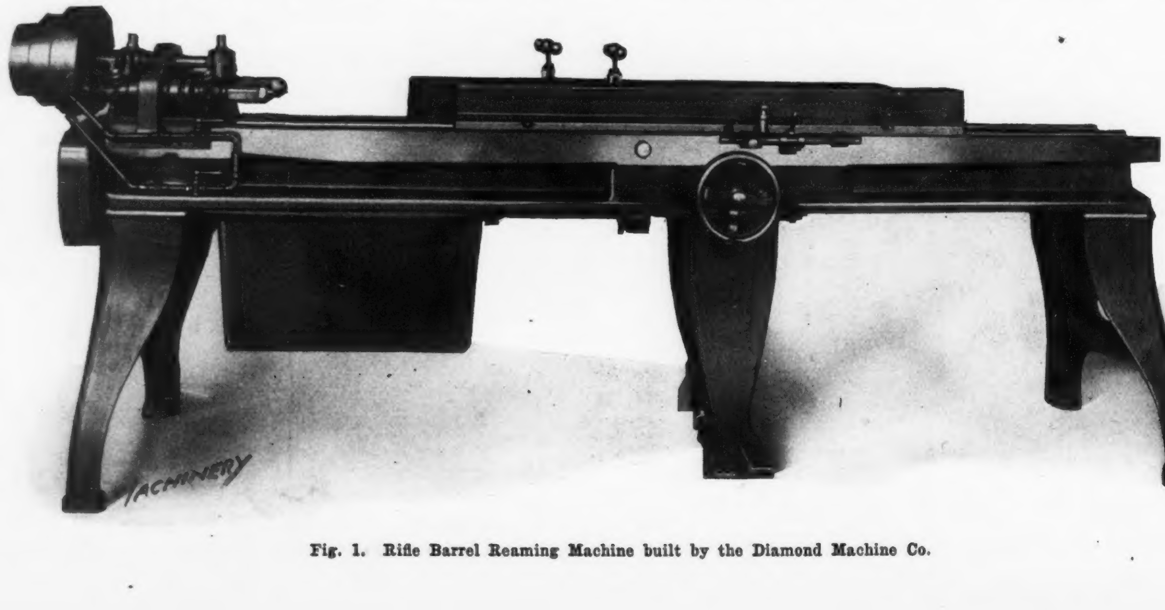


Fig. 1. Rifle Barrel Reaming Machine built by the Diamond Machine Co.

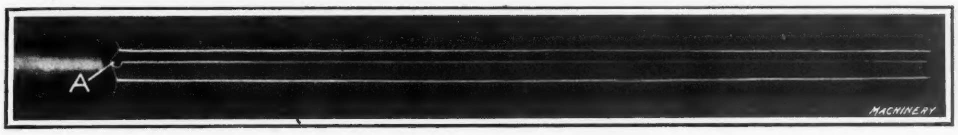


Fig. 2. Type of Reamer used for reaming Rifle Barrels

the hole in the work. These means are provided by guard A, Fig. 1, which carries the bushing that supports the outer end of the rifle barrel; the oil and chips escape into this guard from which they drop down into the pan under the machine. This pan is provided with a strainer which holds back the chips, but allows the oil to flow through into the reservoir where it is ready to once more be pumped to the work.

When working on military rifles, these machines are ordinarily driven at a speed of 1500 revolutions per minute and the drill is fed to the work at rates of feed which cover a range of from 0.2 to 1.0 inch per minute. The rate of production is about three barrels per hour from each two-spindle machine, *i. e.*, a barrel forging can be set up in the machine, drilled and removed in approximately forty minutes. Fig. 5 shows a machine built by the Diamond Machine Co. which is

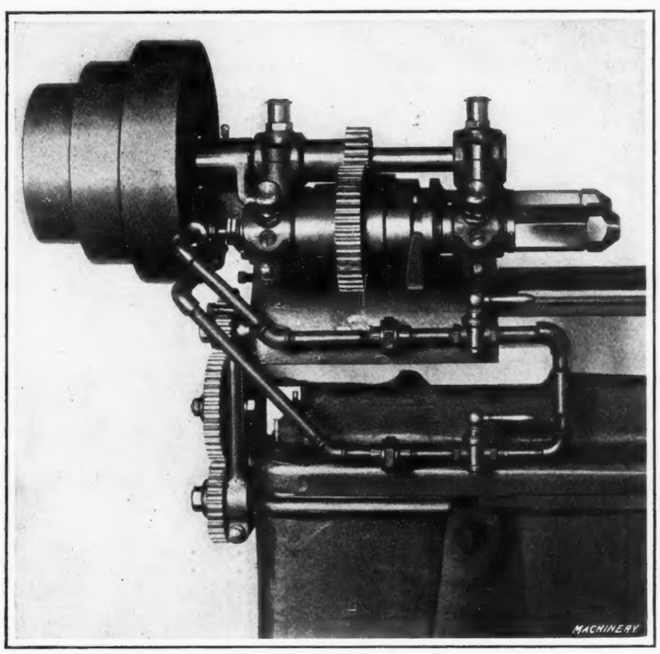


Fig. 3. Close View of Head End of Machine with Guards removed to show Transmission

of essentially the same design as the rifle barrel drilling machine which has just been described. This machine, however, is used for drilling the receivers of rifles, and as the work is considerably shorter than a rifle barrel, it is unnecessary to provide so great a capacity. As a result, the rifle receiver drilling machine is made much shorter.

DIAMOND RIFLE BARREL AND RECEIVER REAMING MACHINES

As in the case of the Diamond drilling machines, these machines for reaming rifle barrels and receivers provide for working on two barrels or two receivers at a time. It will be evident that the work is supported by fixtures mounted in independent carriages which provide for feeding it over the reamers mounted in the revolving spindles. The rifle barrel reamers are hollow so that oil is fed through them to the work. The reamers used for the receivers are solid, and in this case lubricant is supplied through a tube connected to the open end of the work by means of special stuffing-boxes clamped to the ends of the rifle receivers.

After rifle barrels have been drilled they are subjected to a reaming operation, and for doing this work the Diamond Machine Co., Providence, R. I., is building a duplex barrel reamer which is shown in Fig. 1. The machine is provided with two work-holding carriages, which are reciprocated on the bed by independent drives; and the reamers are mounted in the spindles of the machine. Located in the bed are two driving rods which transmit motion to the carriages by means of a worm and wheel, a set of three bevel gears, and a pinion on a vertical shaft, which meshes with a rack on the carriage. Between the two bevel gears on the driving shaft is a clutch which may be shifted to engage either of the gears to provide

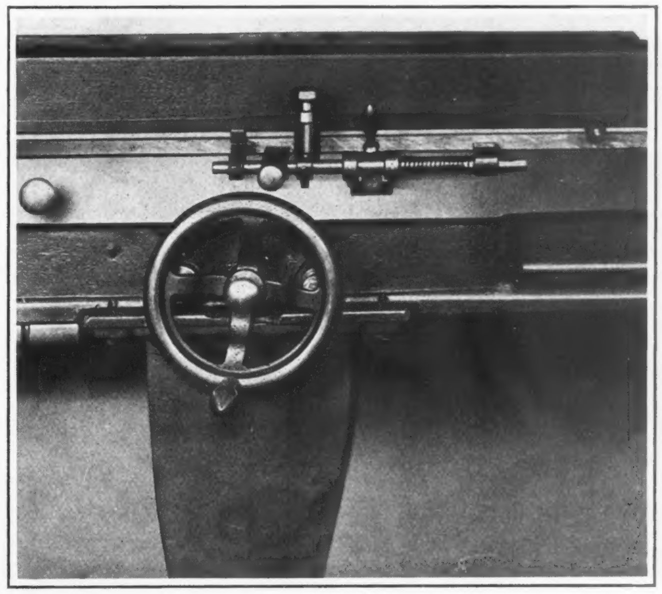


Fig. 4. Close View at Center of Bed, showing Feed Reversing Mechanism and Wheel for Rapid Hand Traverse

for feeding the carriage and work over the reamer or traversing it back to the starting point. The handwheel located above the middle leg provides rapid hand traverse for both carriages, and the clutches on each drive are automatically tripped to provide for reversing the motion to return the carriage to the starting point.

Fig. 2 shows a reamer of the type used on this machine; these reamers are hollow so that oil can be passed through the tool, from which it escapes by way of hole A. Referring to the close view of the head end of the machine shown in Fig. 3, it will be seen that oil pipes are provided to deliver lubricant to each of the spindles and thence through the reamer to the work. In this illustration the guards have been removed from the gearing to show the way in which power is transmitted to the carriages and spindles. The gears at the end of the machine transmit motion to the driving rods which transmit power to the feed mechanism below the carriages.

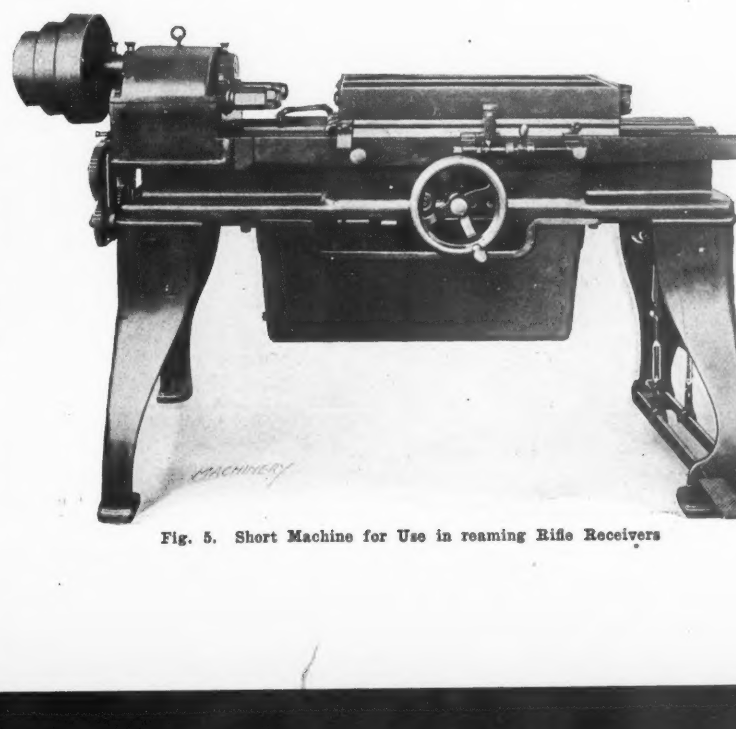


Fig. 5. Short Machine for Use in reaming Rifle Receivers

It will also be noticed that clutches are provided on each of the spindles; these are controlled by the two treadles shown at the base of the middle leg in Fig. 1, and by depressing either or both of these treadles the rotation of one or both of the reamers may be stopped.

For the purpose of reaming rifle receivers, the Diamond Machine Co. is building a tool of practically the same design as that shown in Fig. 1; but as the work handled on this machine is much shorter than the rifle barrels, it is unnecessary to provide carriages and a bed of such great length. By comparing the illustrations of the rifle receiver reaming machine shown in Fig. 5, with the rifle barrel reaming machine illustrated in Fig. 1, it will be evident that they are practically identical so that a detailed description of the receiver reamer is unnecessary. In this connection it may be well to point out that solid reamers are used for the rifle receivers in place of the oil-tube reamers used in the barrels. In reaming the receivers, a stuffing-box is screwed up against the end of the work and this is connected with a tube through which a copious supply of lubricant is delivered to the work. In this way the reamer is kept flooded so that heating of the tool is impossible. The pump for this purpose is contained in the reservoir under the bed.

DIAMOND RIFLING MACHINE

This rifling machine employs what is known as the "hook" type of cutter which cuts the groove as it is drawn through the barrel. The cutter is idle on the forward stroke of the bar. The required lead for the spiral grooves in the barrel is obtained by a rack and pinion actuated by an adjustable guide on the machine. The rifle barrel is automatically indexed to bring successive grooves into the working position, and the feed of the tool for taking cuts of constantly increased depth is also automatically controlled.

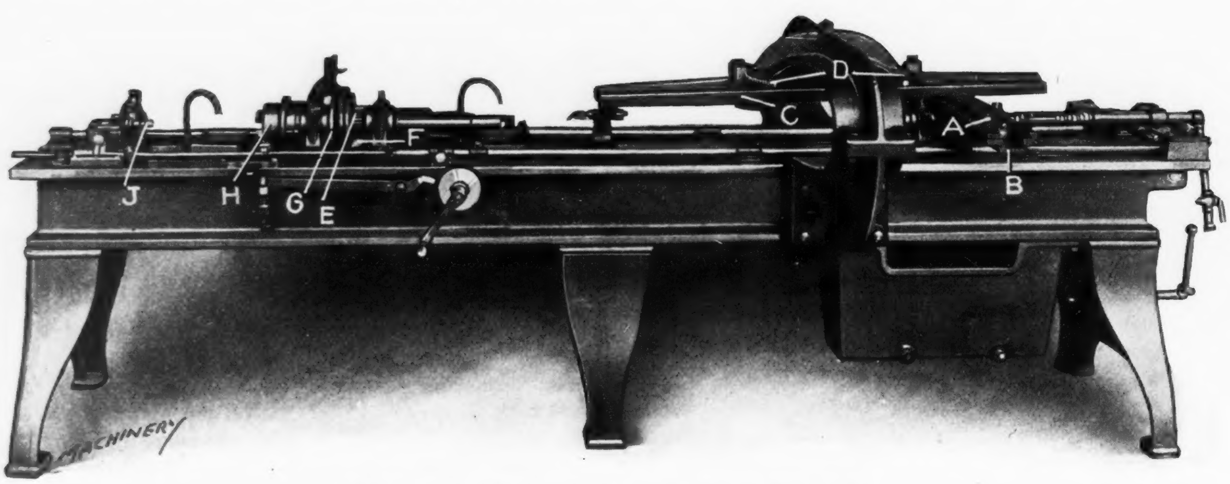


Fig. 1. Rifling Machine built by the Diamond Machine Co.

In the type of rifling machine now being built by the Diamond Machine Co., Providence, R. I., the rotation of the cutter-bar to make it follow the twist in the barrel is obtained by quite a different form of mechanism from that employed on the crank type of machine built by the Baush Machine Tool Co. and described in the November number of MACHINERY. In the present case the cutter-bar is mounted in a carriage which is given a reciprocating motion along the bed of the machine by means of a lead-screw and planer type of belt drive. The mounting which holds the cutter-bar is free to revolve in bearings in the carriage, and a pinion is provided on this mounting which meshes with a rack *A* supported in cross-slide *B* which is an integral part of the carriage.

At the top of rack *A* there is a roller which enters a slot

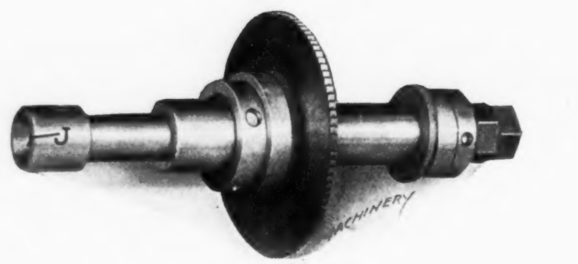


Fig. 3. Close View of Feed Mechanism

in the under side of guide arm *C*. This guide arm may be set at any desired angle with the line of travel of the carriage, graduated scales *D* being provided to facilitate the making of this setting. It will, of course, be evident that as the carriage moves back and forth on the bed of the machine the travel of the roller carried by rack *A* in the groove in guide *C* will result in giving the rack a transverse movement, and this movement of the rack results in rotating the pinion on the cutter-bar mounting and also the cutter-bar. By making the proper angular setting of guide *C* the cutter-bar may be given the necessary rotation so that the required form of groove will be cut in the rifle barrel.

In considering the work done by this machine, it must be borne in mind that there are four grooves in most types of military rifle barrels, and in cutting these grooves it is necessary to index the work at each stroke of the cutter-bar. On the rifling machines built by the Diamond Machine Co., this is accomplished by means of a pinion *E* on the work-spindle which meshes with a transverse rack carried in a slide on the bed of the machine. As the carriage and cutter-bar move forward, the plunger is automatically withdrawn from index plate *G*, after which a transverse movement is imparted to rack *F*, which results in rotating pinion *E* and the work-spindle until the plunger drops into the next notch in the index plate. The work is thus located in position ready for the grooving operation to be performed on the return stroke of the cutter-bar. The rifle barrel is held in a three-jawed chuck *H*.

This machine employs what is known as the "hook" type of cutter, and it has already been stated that the cutting action of this tool takes place during the return stroke of the bar through the rifle barrel. Fig. 2 shows the end of the cutter-bar, the hook cutter being shown at *A*. In the case of a rifle barrel having four grooves, it is necessary to adjust the tool to take a deeper cut after each four strokes of the bar through the rifle barrel. This is accomplished by means of a square headed screw *B* which pushes in a wedge under the hook cutter to force it out so that the cutting edge is at a greater distance from the axis of the bar. This adjustment is made automatically through the entrance of the

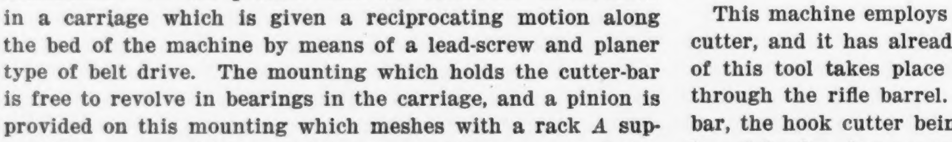


Fig. 2. End of Rifling Bar, showing Cutter and Feed-screw

square head B of the screw into socket J of the feed mechanism, as shown in detail in Fig. 3, from which the construction will be readily understood.

When the cutter-bar has reached the end of its forward movement, the square head of the feed-screw on the cutter-bar enters socket J, and while in this position the ratchet and pawl on the feed mechanism turn the feed-screw, which results in driving in the wedge under the hook cutter so that the cutting edge is moved out from the axis of the bar through the required distance. It must be understood that this movement of the cutter is extremely slight, as the entire depth of the groove in the barrel is only 0.004 inch. In order to prevent damaging the edge of the cutter during the forward or idle stroke of the bar through the rifle barrel, the design has been worked out in such a way that the cutter automatically slips back off the wedge which controls its position, so that it is entirely clear of the work.

LEWIS SPRING MACHINE

The machine shown in the accompanying illustrations was designed and perfected by Fred H. Lewis, president of the Lewis Spring & Axle Co., Chelsea, Mich., for the purpose of forming and hardening automobile springs, and this concern is now manufacturing the machine for the market. It is claimed that this equipment not only constructs springs rapidly and with a great saving of labor, but that it also effects an increase in the strength of the spring. It will be evident from the illustrations that the machine employs the revolving head principle; the spring leaves are heated and then placed in the forming holder, shown in Fig. 1, after which the head revolves and plunges the spring into a tempering bath. At the same time the other head is brought to the top of the receiver ready to have another spring leaf put in position. The machine will turn out leaves at the rate of 1800 per day. The steel is drawn to shape and hardened without the necessity of hammering, and this is said to be the means of preserving the original fiber structure of the metal.

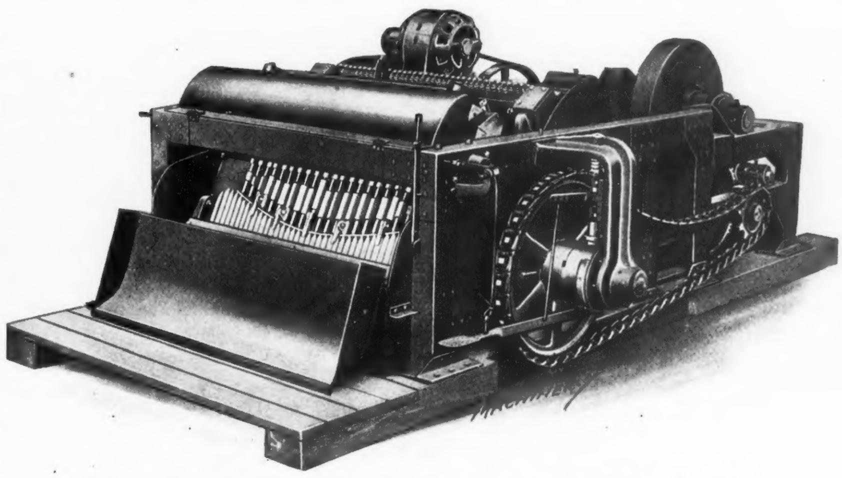


Fig. 1. Lewis Spring Machine with Cover opened to show Forming Holder

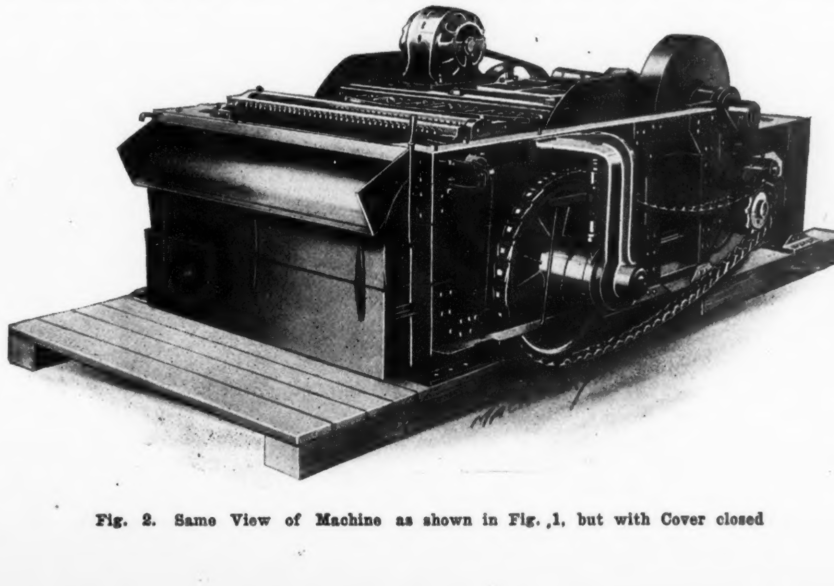
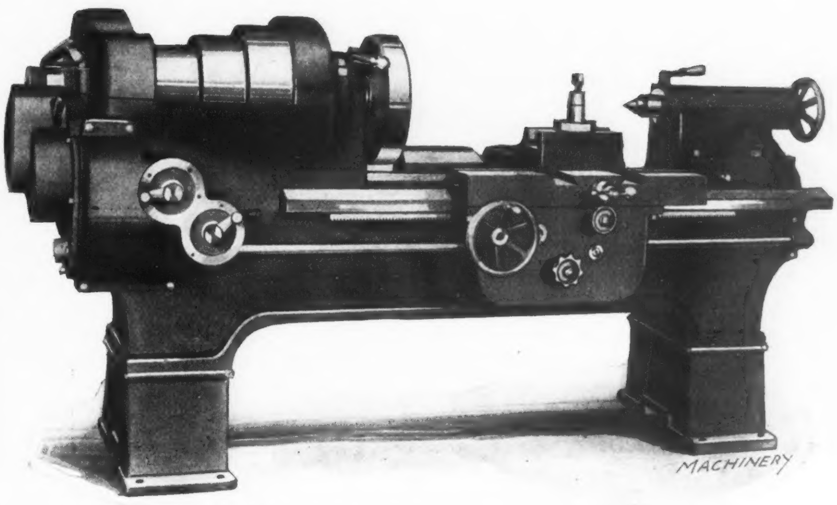


Fig. 2. Same View of Machine as shown in Fig. 1, but with Cover closed



Heavy-duty 20-inch Lathe built by the Economy Engineering Co.

ECONOMY ENGINE LATHE

The Economy Engineering Co., Willoughby, Ohio, is now building a single-purpose manufacturing lathe which is shown in the accompanying illustration. The machine is provided with eighteen changes of speed and a sufficient number of feed changes to cover all ordinary requirements; in fact, it will handle all ordinary classes of work done on an engine lathe, with the exception of thread cutting, and is well adapted for heavy machining operations on forgings due to its exceptional weight and rigidity.

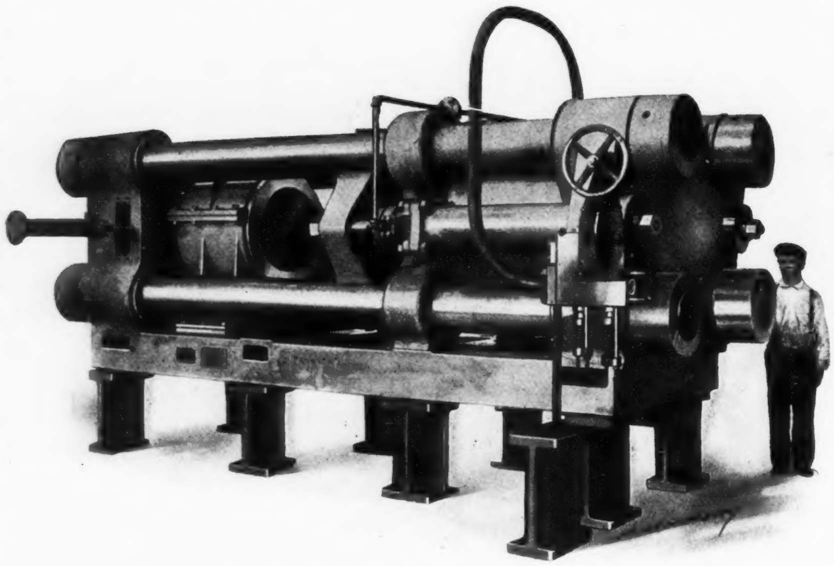
The headstock is of an improved construction with the outside housing brought up to the center line of the cone which has three steps 11, 13 11/16 and 16⅜ inches in diameter by 5 inches face width. A double back-geared drive is provided, the ratios being 3.17 to 1, and 11 to 1. The spindle is made of high-carbon steel and has a No. 6 Morse taper; the diameter of the hole through the spindle is 2 1/16 inches. The front spindle bearing is 4 inches in diameter by 7 inches long, and the rear spindle bearing is 3½ inches in diameter by 5 inches long. Eighteen spindle speeds are provided which are in geometrical progression and range from 11 to 335 revolutions per minute.

The bed is made unusually deep and is furnished with a wide V-bearing at the front which resists the thrust of the tool in all directions, and a flat bearing at the rear. The length of the carriage bearing on the bed is 32 inches, and the carriage is clamped down at the rear in such a way that easy movement is secured without any backlash. The bridge is 11 inches in width which affords an ample bearing for the cross-slide. The apron is of the box type, and so constructed that all shafts have bearings at both ends. The feeds are operated by frictions and are positively geared through a quick-change box. All bearings in the headstock, feed-box and apron are bronze bushed throughout. The countershaft

is provided with double friction pulleys 18 inches in diameter by 5 inches face width, and both belts should run forward.

The lathe is made with a plain block rest and the slide is furnished with a tapered gib. The regular equipment includes a plain rest, faceplate, countershaft and wrenches. The following special equipment may be provided: Compound rest in place of plain rest; square turret tool-post on cross-slide; four-hole turret mounted on ways in place of tailstock; and power feed. The machine swings 22 inches over the ways and 13 inches over the carriage; the maximum distance between centers is 3 feet 1 inch; and with an eight-foot bed the approximate weight of the machine is 5100 pounds.

SOUTHWARK EXTRUSION PRESS



Extrusion Press built by the Southwark Foundry & Machine Co.

In the extrusion press recently developed by the Southwark Foundry & Machine Co., Philadelphia, Pa., the design and method of operation have been worked out in a way which insures a high rate of production with the minimum cost for tool upkeep and power. The method of operation is such that no annealing is required and the extrusion is completed in a single operation. Furthermore, it is unnecessary to employ a pickling operation except in cases where some special finish is required.

The pressure chamber is made of special alloy steel which has a high tensile strength, and it is provided with a jacket through which the heated gases from the fireplace beneath the chamber are passed, so that the chamber is heated to the required temperature. The gases escape through a pipe located above the pressure chamber and provide for heating the chamber to a temperature of 600 degrees F. The chamber is heated so that the metal blocks which have been heated to a temperature of from 1650 to 1800 degrees F. may not be suddenly cooled when placed in position. If they were cooled suddenly, the surface of the metal would lose its plasticity, thereby unduly delaying the extrusion operation or making its successful performance a practical impossibility. The high temperature to which the walls of the pressure chamber are raised, during the time in which the extrusion operation is being performed, requires the chamber to be made of steel of an exceptionally high quality. A special grade of alloy steel is used for this purpose.

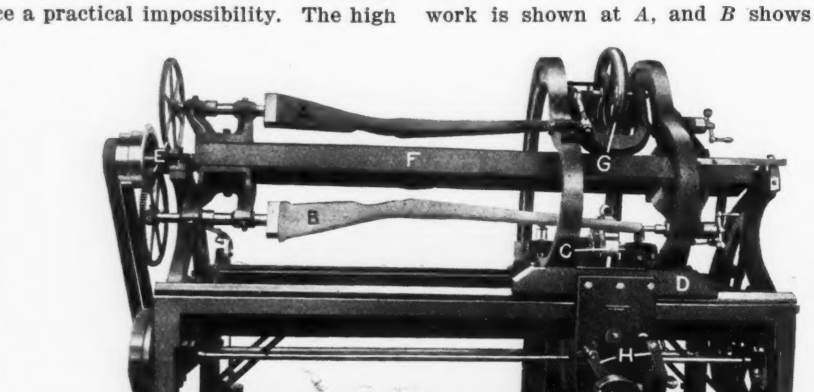
The Southwark extrusion press is operated from an accumulator which is fitted with a special safety valve that absolutely prevents dropping at a dangerous speed, even though a pipe line should fail. The safety valve also acts as a governor and automatically regulates the extruding speed to that which is most economical. The press has a cast-iron table 50 feet long to support the extruded rods, and between this table and the back edge of the press there is a 30-ton cutting-off press to sever the ram stump of the billet from the die-block. The stroke is of ample length to enable the press to be used for drawing hot copper tubes after the container castings are removed.

GILMAN RIFLE STOCK TURNING MACHINE

For some years the firm of Gilman & Son, Inc., Springfield, Vt., has been manufacturing a gun stock turning machine adapted for making short stocks for shot guns and sporting rifles. But this machine has not sufficient capacity for handling military rifles in which the stock extends along under the barrel almost to the muzzle; and to meet the requirements of such work a new machine has been developed, which operates along essentially the same lines as the standard gun stock turning machine, except that it has an increased capacity between centers. As the turning of rifle stocks is work that is necessarily done in only a few shops, the operation of a stock turning machine is probably a matter with which most mechanics are unfamiliar, and on that account a description of the new Gilman machine will doubtless prove of interest.

In operation, the stock to be turned is sawed out on a band saw so that there is not more than ½ inch of material to be removed at any point. This rough block is then set up on the machine and the forming of a rifle stock from the block is performed by a rotary cutter-head mounted on a carriage which runs on V-bearings on the bed. The roughing out of the stock is completed at a single traverse, and the form of the work is governed by a model carried on the machine.

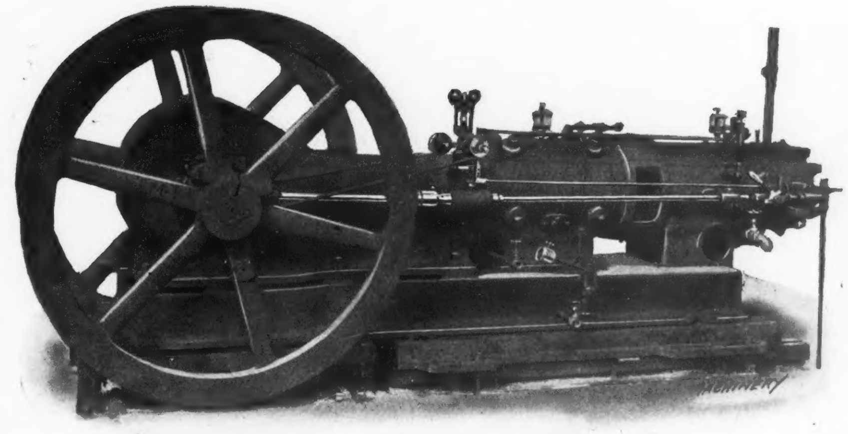
With the brief explanation given, we are in a position to enter into a detailed description of the manner in which the machine operates. The model which governs the form of the work is shown at *A*, and *B* shows a rifle stock which has just been roughed out. The rotary cutter-head *C* is equipped with four tools equally spaced around its periphery; this cutter-head is mounted on the carriage *D* which runs on V-bearings on the bed, and receives its traverse motion from a rack and pinion. The model *A* and work *B* are rotated by means of gears *E* which mesh with a common pinion, and both the work and model are supported on centers carried by a cradle *F* which rocks on a central pivotal support. The engagement of wheel *G* with



Military Rifle Stock Turning Machine made by Gilman & Son

model *A* results in swinging cradle *F* about its pivotal support in such a way that the depth of cut taken by the tools in head *C* will be so regulated that work *B* will be an exact reproduction of model *A*. The general structural features of the machine will be evident from the illustration.

It has been mentioned that the turning of a stock is completed by a single traverse of the carriage, and the carriage is fed along the bed at a rate of 3 inches per minute. There are four cutters in the cutter-head, but only three of these are active during a single traverse of the carriage. The reason for this is that the gearing in the apron of the machine is designed to provide for reversing the power traverse of the carriage in order to save the time which would otherwise be lost in returning the carriage to the starting position. There are two roughing cutters, one intermediate and one finishing cutter in the head, but the roughing cutters are so arranged that one cutter takes a cut when the carriage is being traversed in one direction and the other roughing cutter is idle; when traversing in the opposite direction, the cutter which was formerly idle does the work. The power traverse of the apron is automatically tripped when the cutters reach the end of the work, and when a fresh blank has been set up on the machine the gearing must be reversed by adjusting handles *H*, in order to provide power traverse in the opposite direction. Stocks for military rifles can be turned out on this machine at the rate of four per hour.



Chicago Pneumatic Tool Co.'s Type N-SO Air Compressor driven by a Fuel Oil Engine

CHICAGO FUEL OIL DRIVEN AIR COMPRESSORS

For the purpose of reducing the cost of operating an air compressor, the Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., has developed a type N-SO compressor which is driven by an engine capable of operating successfully on the lowest grades of fuel oil. One of these machines is shown in the accompanying illustration, and they are said to be well suited to heavy duty under such severe conditions as exist in mines and on contracting jobs, in addition to regular stationary service. The engine is guaranteed to run satisfactorily on any mineral oil having a specific gravity of 28 degrees Baumé or lighter, which does not contain over 1 per cent of sulphur. There are a number of commercial fuel oils obtainable for three cents per gallon which fulfill these specifications, and with such fuel the type N-SO compressor is warranted to compress air to a pressure of 100 pounds per square inch at a cost of not over fifty-six cents per nine-hour day for each 100 cubic feet per minute of free air which is delivered to the receiver. These figures are so low that they seem almost incredible, but it is claimed that machines which have been in service long enough to fully demonstrate their economy of operation are actually running at a figure well under this cost.

It will be seen that the type N-SO compressor is a horizontal unit; it is of the straight-line, single-stage type with the compression cylinder bolted to the main frame and connected in tandem to the power ends. The propulsive cylinders are of the valveless, two-cycle, low-compression type; and ignition is produced by a positive acting hot plate system. As in the case of the Diesel engine, combustion takes place at the end of the compression stroke and the combustion is so complete by the time the exhaust port is opened that the fuel loss is practically negligible. A small oil pump injects the oil against the hot plate on the piston as it approaches the end of the compression stroke, and increased economy of operation is obtained by the use of water with the fuel oil. The quantity of both oil and water admitted to the combustion chamber is controlled by a fly ball governor. An important feature of the compressing cylinders is that they employ the Chicago Pneumatic "Simplate" flat disk air inlet and discharge valves which were described in the December number of MACHINERY. The type N-SO compressors are made in both single and duplex units. The single compressors come in six standard sizes having strokes of 8, 10, 12, 14, 18 and 21 inches.

BAUSH RIFLE RECEIVER SPLINING MACHINE

In the action of a military rifle, the cartridge is pushed into the chamber, after which the bolt is moved forward to bring the firing pin into contact with the cartridge primer. After the bolt has been pushed forward in this manner, it is necessary to have it clamped in place, and this is done by having keys on the bolt which fit into splined grooves in the receiver. When the bolt is pushed forward these keys slide in the spline groove and it is not free to turn until the firing pin comes into contact with the base of the cartridge; but at this point the back ends of the keys are just beyond the ends of the spline grooves, the keys themselves being in a socket at the end of the receiver. As a result, the bolt may now be turned to move the keys out of alignment with the spline grooves in the receiver, so that they bear against the end of the receiver and hold the bolt firmly in place against the base of the cartridge.

Rifle Receiver Splining Machine built by the Baush Machine Tool Co.

In machining the receivers, the work of cutting these spline grooves is somewhat analogous to that of cutting the rifling grooves in the barrels. The work is done by a tool similar to the "hook" cutter used on the rifling machine, and the method by which the position of the cutter is adjusted in the

bar to provide for taking a deeper cut at each stroke is controlled by a screw and wedge mechanism of similar construction to that of a rifling bar equipped with a "hook" cutter. But there is one important difference, *i. e.*, the cutter does not clear the work on the return stroke but cuts on both forward and return strokes.

It will be evident from the illustration that this is a duplex machine, *i. e.*, there is a cutter-bar carried at each end of the slide *A* at the center of the machine, and two work-holding fixtures (not shown in the illustration) in which the receivers are supported while the splining operation is performed. The sockets by which the position of the cutters in the splining bars is adjusted to take progressively deeper cuts are shown at *B* and *C*, and it will also be observed that oil tubes provide for delivering a supply of lubricant to the work. Oil for this purpose is delivered by a pump located in the reservoir inside the column of the machine. The cutter-slide is reciprocated on the bed by means of a pitman which may be set for any required length of stroke. Hand adjustment of the position of the slide is obtained by means of the handwheel at the front of the machine. This machine is a product of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass.

THREAD MILLING ATTACHMENT

To provide for the rapid performance of threading operations, the New England Butt Co., Providence, R. I., has recently designed a thread milling attachment for use on an ordinary 16-inch engine lathe. This equipment is used for

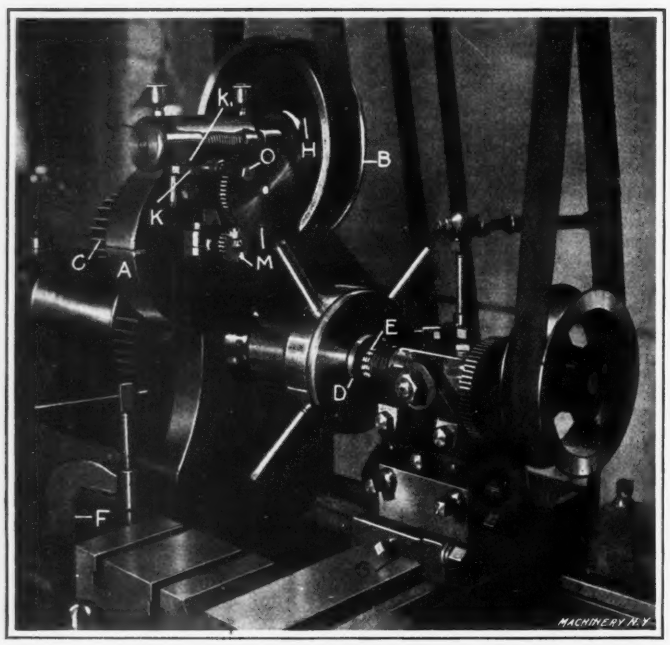


Fig. 1. New England Butt Co.'s Thread Milling Attachment for the Lathe

milling the coarse thread on the outside of the ogive for 70-millimeter shrapnel shells, and has now been in operation for a sufficient length of time to fully demonstrate its ability to give satisfactory results as regards both finish and rate of production.

By referring to Fig. 1, the design of the mechanism and method of operation will be readily understood. The bronze worm-wheel in case *A* is driven by pulley *B*, and the worm-wheel shaft carries pinion *C* which meshes with the large gear on the cone pulley. In this way the spindle is given a backward motion. Piece *D* to be threaded is held in the chuck by means of a collapsible collet, and after it has been set up cutter *E* is moved in to the full depth to which the thread is to be cut. The cutter is located by bringing the carriage up against stop *F*, and the cutter is then fed in to the full depth of the thread by bringing the cross-slide into contact with stop *G*. Clutch *H* is next engaged by pulling forward knob *J* until stops *K* are engaged, which results in starting the spindle rotating. After the spindle has made

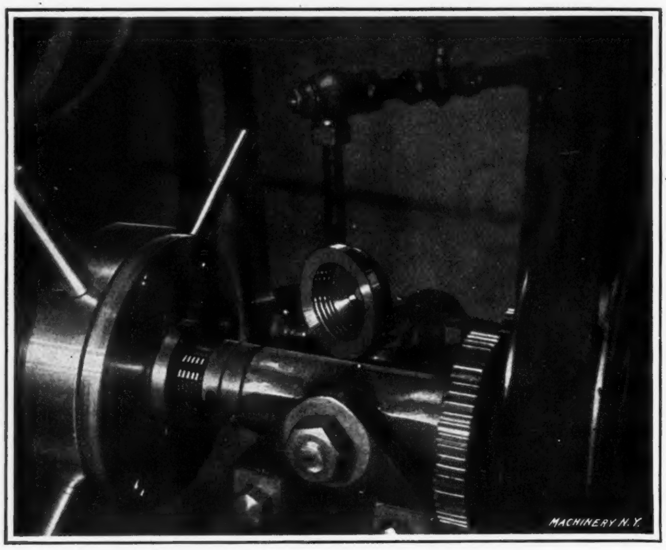


Fig. 2. Close View of Chuck and Cutter Spindle

about 1.1 revolution—the movement being governed by gears *M*—stop *K* is automatically thrown out by the action of knock-out pin *O*, and the work is then ready to be removed from the chuck.

The lathe is geared up in the same way as for a regular thread cutting operation. The cutter resembles a hob in appearance, but the grooves are straight instead of spiral, *i. e.*, the cutters are of exactly the same form as those used on several types of thread milling machines recently placed on the market. The movement of the carriage along the bed gives the required pitch for the thread, this pitch being obtained by the gearing of the lathe as previously mentioned. Fig. 1 shows the attachment engaged in cutting an 8-pitch Whitworth standard thread in the ogive of a 70-millimeter shrapnel shell, and the time required for threading a piece of this type is 2½ minutes, which includes the time required for handling.

MURCHEY THREADING DIE AND TAP

In the manufacture of fuses for shrapnel and high-explosive shells, the necessity has arisen for machining various parts on which there is an internal and an external thread. To handle this work in the most expeditious manner, it is obviously desirable to perform the internal and external threading operations simultaneously, and the demand for tools for this purpose has been well met by the Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., in the combination threading die and tap illustrated and described herewith. Reference to the illustration will make it evident that this tool consists of the combination of a sizing tap with one of the Murchey threading dies; and both the tap and the die are provided with means of adjustment to control the size of the work.

The adjustment of the tap is obtained by a screw that governs the position of a tapered plug which is engaged by the

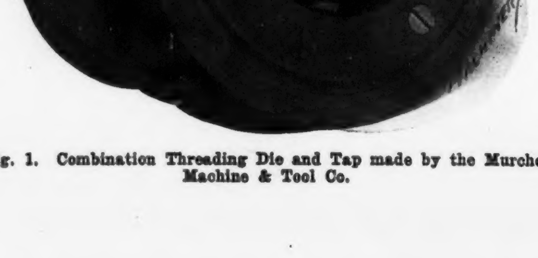


Fig. 1. Combination Threading Die and Tap made by the Murchey Machine & Tool Co.

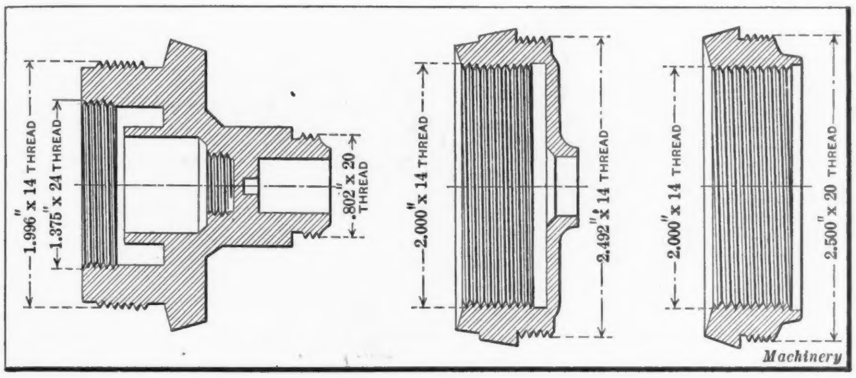


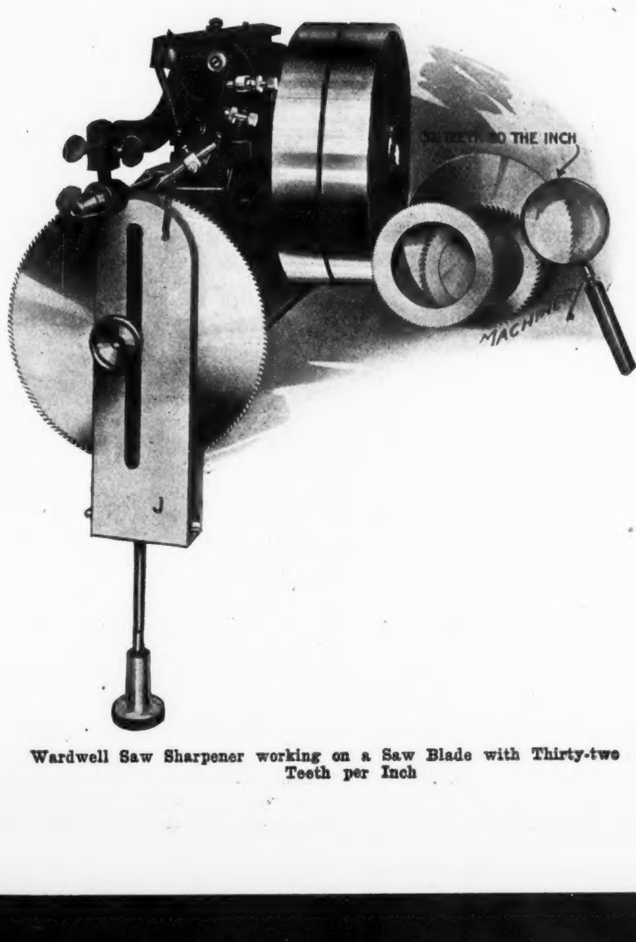
Fig. 2. Types of Work on which Combination Threading Die and Tap is used

backs of the chasers. Similarly, the adjustment of the die is obtained by drawing a tapered collar up over the backs of the chasers. This, of course, is practically the standard form of construction. Fig. 2 shows typical examples of the classes of work for which a tool of this type is adapted, and in addition to its application in threading fuse parts, a combination tap and die of this type could be used to advantage in machining a variety of other metal products. It will be evident from Fig. 2 that the use of this tool is not limited to work where the pitches of the internal and external threads are the same. To provide for handling work where the pitches vary in this way, the tap is free to move longitudinally, thus making correction for the difference in movement of the tap and die along the work.

WARDWELL CIRCULAR SAW SHARPENER

The following describes a filing machine for sharpening circular saws, which has recently been placed on the market by the Wardwell Mfg. Co., 110-112 Hamilton Ave., Cleveland, Ohio. This machine is adapted for resharpening small circular saws ranging from 3 to 12 inches in diameter, with from 2 to 32 teeth per inch. The machine is known as the model J saw sharpener, and is particularly adapted for sharpening fine toothed saws used for cutting brass and copper tubing. It was originally designed to meet the special requirements of an automobile plant, but has proved so successful that it was decided to build the tool for the market.

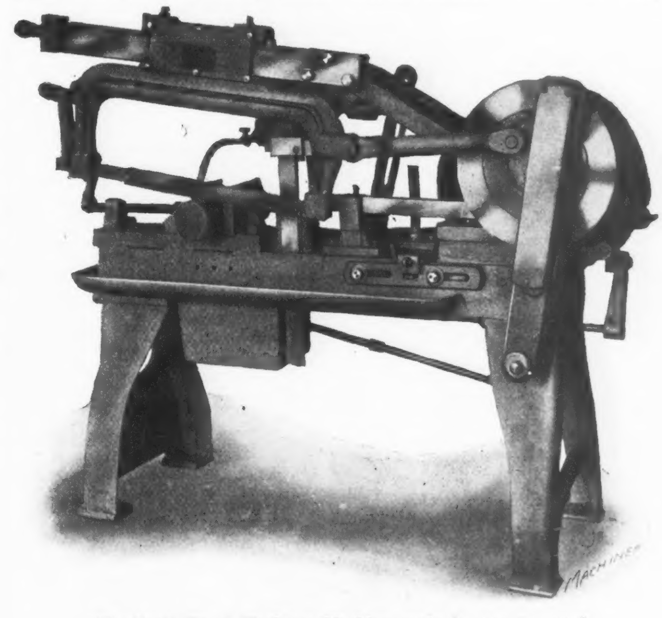
The filing arm works between heavy adjustable steel slides, and when it is known that the sharpening of fine saws is done at a speed of from 80 to 90 teeth per minute, it will be evident that this steel slide construction is important. The elliptical movement which may be imparted to the filing arm enables teeth having a hook to be resharpened. Another important feature is the double pawl positive feed movement which was designed to operate as follows: One feed pawl works on each side of the file, so that the pawl on the left side is always pushing against a tooth that has been evenly spaced and given a clean face, while the pawl on the right side of the file works one tooth behind the tooth that is being sharpened and provides for evening up the teeth. By means of this double pawl feed movement all teeth are filed absolutely uniform, *i. e.*, they are brought to the same width and length. But the chief feature of the double pawl movement is that where small teeth are broken out—a condition frequently met with where fine toothed saws are used for cutting metal—the saw still continues to be fed through the machine. All wearing parts of the machine are made of steel.



Wardwell Saw Sharpener working on a Saw Blade with Thirty-two Teeth per Inch

DIAMOND HACKSAW MACHINE

The Diamond Saw & Stamping Works, Buffalo, N. Y., have recently added to their line of "Sterling" power hacksaws a No. 5 heavy-duty machine which is illustrated and described herewith. The design and construction of this saw have been worked out along lines which enable it to cut very rapidly when running at only fifty or fifty-five strokes per minute, and operating at this slow speed means a material increase in the life of the saw blades. The latter is a particularly important factor at the present time, owing to the large number of round steel bars, high in carbon and manganese, which are being cut up for manufacture into shrapnel and high-explosive shells. Normally weighted and equipped with a sharp new blade, this machine has a capacity for cutting a 3½-inch round steel bar in from three to four minutes, and has made thirty-two cuts with a single blade on 3½-inch round steel bars having a high percentage of carbon and manganese; in this case, the average time per cut was 5½ minutes. The machine is intended for cutting material in sizes up to the equivalent of 6-inch round bars. The usual provision is made for automatically lifting the saw from the work on the idle stroke, and the mechanism provided for this purpose is positive in its action.



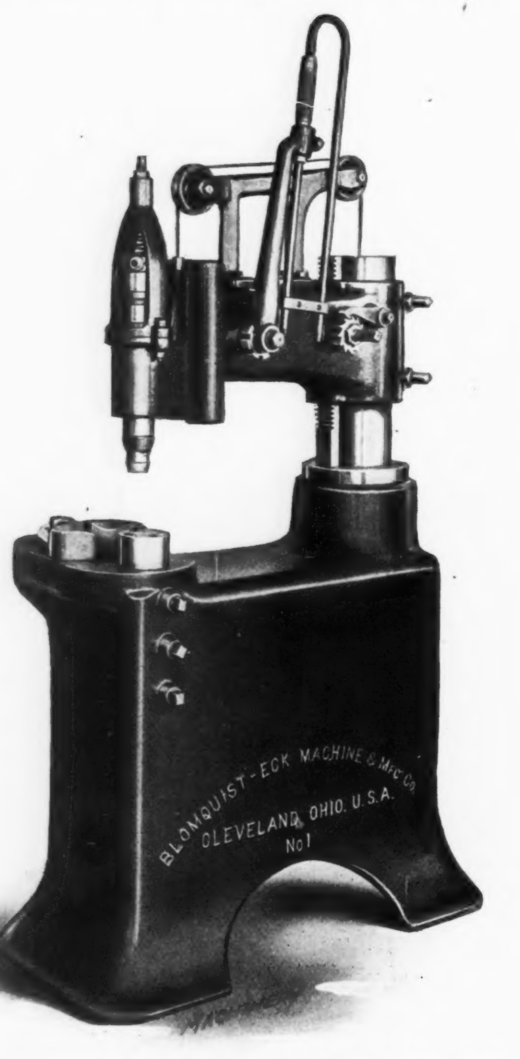
"Sterling" No. 5 Hacksaw Machine made by the Diamond Saw & Stamping Works

BLOMQUIST-ECK PNEUMATIC RIVETER

The machine which forms the subject of the following description was designed by the Blomquist-Eck Machine &

Mfg. Co., Cleveland, Ohio, for the purpose of heading over the ends of hub flange bolts on automobile wheels to prevent the nuts from being loosened by vibration, but it is equally applicable for a variety of other riveting operations. It will be seen that the machine has a heavy base to absorb vibration, and the design has been worked out in such a way that the anvil seat can be changed to suit the requirements of the work; also, it will be noticed that the column is set well back to provide a deep throat. The box section frame which supports the mechanism is raised and lowered by a rack and pinion provided with a ratchet and pawl stop; and it is held in position by two binding screws at the rear, which clamp the frame to the column. Sidewise location is provided by rotating the frame on the column in relation to the anvil.

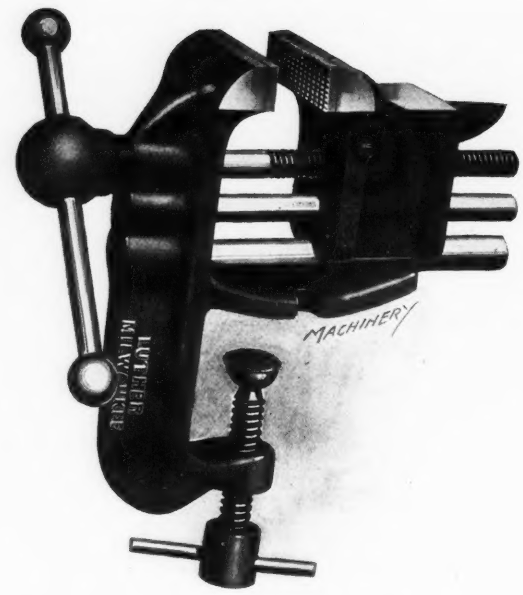
The hammer is of a standard make; it provides for delivering a heavy blow and is so attached to the slide that the recoil is absorbed by a yoke and spring as shown in the illustration. The slide is scraped to fit the dovetailed end of the frame, and adjustment for wear is afforded by a tapered gib. The slide is counterbalanced by a weight in the base of the machine, to which it is connected by a wire cable running over pulleys on the frame. The slide is brought down to the work by means of the rack and pinion which are actuated by a handle at the side of the machine. Air is admitted to the hammer cylinder through a looped pipe; and a knurled handle which has an oscillating movement provides for opening and closing the valve. Connection to the pipe line is made through a hose connected to the open end of the looped pipe. Hammer sets and anvils are furnished to suit the work.



Pneumatic Riveter made by the Blomquist-Eck Machine & Mfg. Co.

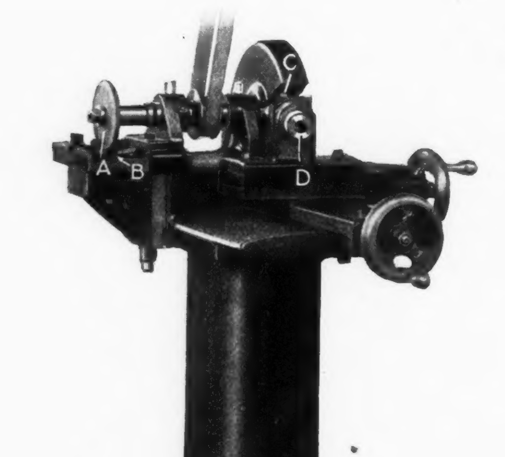
LUTHER CLAMP VISES

The Luther Grinder Mfg. Co., Milwaukee, Wis., has recently developed a line of clamp vises provided with guides, screws, jaws and handles made of steel. The movable jaw in these vises comes above the steel guides which, in turn, are supported by the bench. This construction makes it practically impossible for the vise to get out of alignment; and the jaws cannot be sprung. It will be apparent by referring to the illustration that an anvil is provided at the back of the movable jaw. This is often a convenience in jobbing shops where a variety of work is handled in the vise.


Clamp Vise made by Luther Grinder Mfg. Co.

BAUSH RIFLE BARREL DRILL GRINDER

To meet the special requirements of sharpening drills for rifle barrel drilling machines, the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has designed and built the grinding machine shown in the accompanying illustration.



Grinder for sharpening Drills used on Baush Rifle Barrel Drilling Machine

For this work it is necessary to grind the drill at the point and in the flute at the side to afford a clearance space through which the chips can escape from the hole. On the Baush rifle barrel drill grinder it will be seen that two wheels are provided at opposite ends of the spindle. The wheel A is used for grinding the flute in the side of the drill, and reference to the illustration will make it evident that a V-block at B affords a convenient means of locating the work in the desired position relative to the grinding wheel; during the grinding operation the drill is clamped down in the vee by means of a strap.

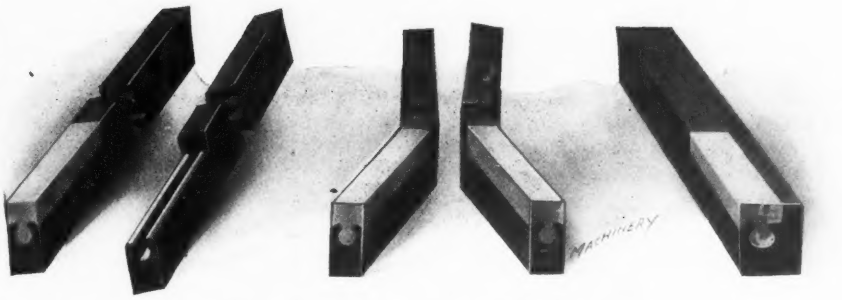


Fig. 1. Examples of "Cast On" Stellite Tools

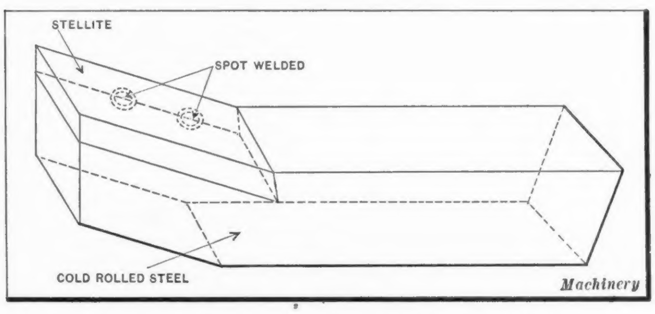


Fig. 2. Tool made from Stellite Cutter spot-welded to Machine Steel Shank

The grinding of the point of the drill is performed by wheel C at the opposite end of the spindle, the drill being introduced through bushing D to bring its point into contact with the wheel. In order to secure the exact form of point necessary to obtain the best results in grinding rifle barrels, this grinding machine is provided with a cam actuated mechanism which rocks the drill on the surface of the wheel so that the required form of drill point is secured.

"CAST ON" STELLITE TOOLS

For the purpose of effecting an economy in the use of stellite, the Haynes Stellite Co., Kokomo, Ind., has recently developed what are known as "cast on" tools, examples of which are shown in Fig. 1. The shanks are made of heat-treated nickel steel, and it will be evident from this illustration that the way in which the seat is formed to receive the cutter prevents the likelihood of the stellite inlay working loose. As the name implies, the stellite is cast onto the shank, and as the melting point of stellite is considerably higher than that of steel, pouring the molten stellite onto the steel shank results in partially fusing the steel so that the joint is welded together. These tools are only made to special order and practically any kind of tool can be furnished.

Fig. 2 shows a tool made in a different way, but in which the object is the same, namely, to reduce the amount of stellite in the tool to a minimum. In this case the stellite is spot-welded to the machine steel shank, and it will be evident from the illustration that the seat is formed in such a way that ample support is provided. The welding of this stellite cutter onto the shank is being very successfully done with machines built by the Detroit Electric Welder Co.

Fig. 3 shows a cross-sectional view of a special type of solid stellite tool which the Haynes Stellite Co. has recently developed for the use of shrapnel manufacturers. The reason for making the tool of this cross-section instead of grinding it from a square bar is that a stellite casting, like castings made from many other metals, is harder and tougher at the surface than at other points of the cross-section. Where it is desirable to secure the maximum strength and hardness, this makes it advisable to remove as little of the outer surface of the metal as possible; hence the practice of casting bars of the exact cross-section which is required, making it only necessary to sharpen the cutting edge of the tool. It is said that this form of tool is giving extremely satisfactory results.

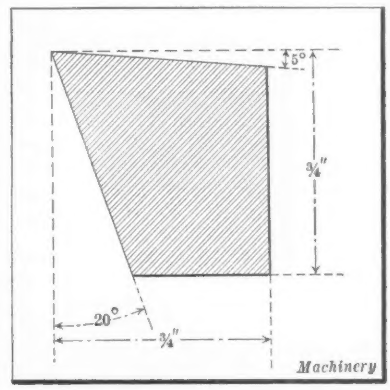
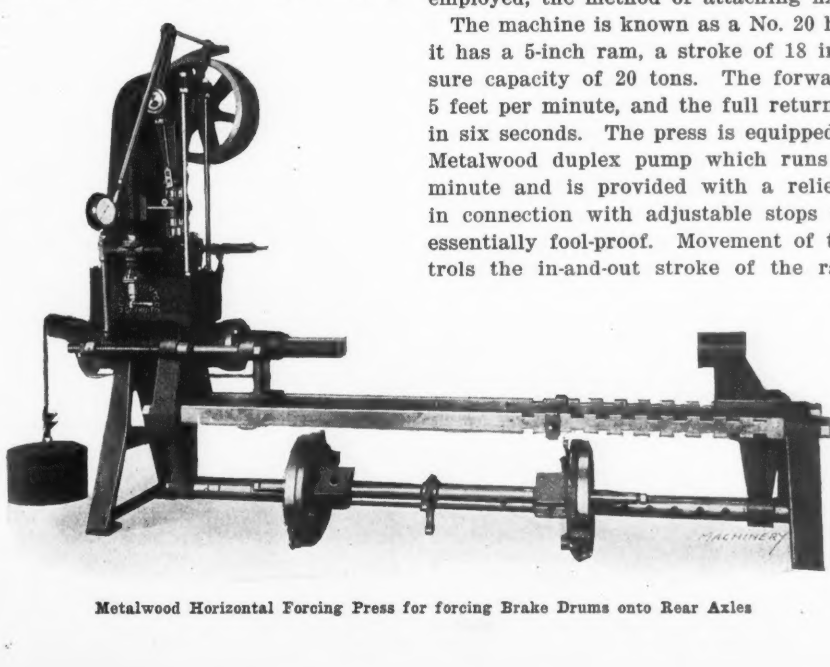


Fig. 3. Solid Stellite Tool for Shell Work

METALWOOD HORIZONTAL FORCING PRESS

The No. 20 horizontal forcing press shown in the accompanying illustration has been developed by the Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich., for use in forcing brake drums onto rear axles. It represents one of several styles of the same type of press which have been built by this company to meet special requirements in various lines of manufacture. Alterations in design only affect the length of the bed, the style of resistance head which is employed, the method of attaching fixtures, etc.

The machine is known as a No. 20 horizontal forcing press; it has a 5-inch ram, a stroke of 18 inches, and a rated pressure capacity of 20 tons. The forward speed of the ram is 5 feet per minute, and the full return stroke is accomplished in six seconds. The press is equipped with a five-horsepower Metalwood duplex pump which runs at 200 revolutions per minute and is provided with a relief mechanism operating in connection with adjustable stops which makes the outfit essentially fool-proof. Movement of the operating lever controls the in-and-out stroke of the ram while the pump is running continuously, and adjustable stops insure the forcing being done to exact distances, thus doing away with the necessity of taking measurements in setting up the work or while the forcing operation is in progress.



Metalwood Horizontal Forcing Press for forcing Brake Drums onto Rear Axles

The Metalwood Mfg. Co. is building these machines equipped with belt drive, individual motor drive, accumulator line drive, or for use in connection with an air pressure intensifier. It is claimed that the same accuracy of operation, convenience of control and speed of production are obtained on this press as on modern high-grade machine tools. The principal dimensions of the press are as follows: Distance from floor to center of ram, 34 inches; maximum length of work that can be handled, 7 feet; minimum length of work that can be handled, 3 feet; floor space occupied, 2 feet 10 inches by 13 feet 6 inches, and weight of machine, 4800 pounds.

CORRECTION—CARPENTER THREADING DIE-HOLDERS

In the article on the Carpenter threading die-holders in the February number, the last sentence should have read as follows: "The Acorn die was first brought out by J. M. Carpenter many years ago, and was shown in his patent granted May 12, 1896."

NEW MACHINERY AND TOOLS NOTES

Bench Miller: Miller & Crowningshield, Greenfield, Mass. A plain bench miller developed for handling a variety of light work. The machine is of exceptionally simple design and incorporates the usual features of machines of this type.

Self-centering Shell Chuck: Jenckes Knitting Machine Co., Pawtucket, R. I. A self-centering chuck for holding shells while they are being machined. The chuck has a machine steel body and is at present being made for handling 3-inch shells.

Clipper Belt Lacer: Clipper Belt Lacer Co., 1020 Front Ave., Grand Rapids, Mich. A No. 3 belt lacer which is provided with additional power to enable belts to be laced easily. The power of the tool enables a man to push 6 inches of hooks into a belt at a time.

Lock-nut: Day & Zimmerman, Philadelphia, Pa. A stamped sheet metal lock-nut of simple construction. The two sides of the nut are bent up to serve the double purpose of providing the necessary rigidity and of affording a bearing for the wrench. This nut is screwed down on top of the regular nut to hold it in place.

Grinding Wheel Guard: Ransom Mfg. Co., Oshkosh, Wis. A grinding wheel guard constructed of boiler plate. The outer plate is hinged to give access to the wheel, and a box is provided at the bottom to catch heavy particles of metal or abrasive. The latter feature prevents the exhaust pipe from becoming clogged.

Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A vertical press adapted for a wide range of straightening, forcing, and broaching operations. The ram pull back is effected by either air pressure or a counterweight. The general features of the design are the same as those on other machines of this company's manufacture.

Pneumatic Riveter: Vulcan Engineering Sales Co., Chicago, Ill. A riveter designed by the Hanna Engineering Works for use on lattice columns and other structural work of a similar nature. The machine is operated by a toggle joint mechanism combined with levers and guide links which provide a large opening and the required degree of pressure.

Sandblasting Helmet: Multi-Metal Separating Screen Co., 77 East 131st St., New York City. A sandblasting helmet which affords complete protection for the operator and at the same time avoids inconvenience due to weight, impaired vision or difficulty in breathing. Free admission of air is provided by a fine mesh screen in the helmet.

Electric Butt Welder: Detroit Electric Welder Co., Detroit, Mich. A small size butt welding machine which is suitable for portable service; it has a capacity for welding iron, steel, copper, brass and a variety of other metals up to 3/16 inch in diameter. The small size and light weight of the machine make it easy to move about the shop from place to place.

Heavy-duty Lathe: Giddings & Lewis Mfg. Co., Fond du Lac, Wis. A heavy-duty boring lathe provided with a bar that has a single cutting tool. The boring-bar with its housing is moved across the bed by means of a forming attachment at the rear of the machine, which causes the bar to travel in such a way that the required contour is produced on the work.

Engine Lathe: Standard Lathe & Tool Co., Cleveland, Ohio. A heavy pattern engine lathe provided with a geared headstock and single pulley drive. There are two speeds in the head and two in the countershaft; five changes of feed are available which are 0.020, 0.040, 0.060, 0.080 and 0.100 inch per revolution. The machine is built with any length of bed from 8 feet up.

Cutting-off Machines: John Hall & Sons, Brantford, Canada. Two types of high-speed heavy-duty cutting-off lathes designed for the purpose of cutting off and facing shrapnel and high-explosive shells. One is a simple machine designed for cutting off shells. The other is a triple cutting-off machine intended for cutting up ingots for high-explosive shells.

Time Study Watch: M. J. Silberberg, Peoples Gas Building, Chicago, Ill. An improved time study watch for use in obtaining data on time and motion studies, and for readily estimating the production per hour or per day on machining operations. The use of the watch is said to eliminate considerable calculation. The watch is a 17-jewel instrument of Swiss manufacture.

Lubricant Pump: Stevens Mfg. Co., Dayton, Ohio. A feature of this pump is that all parts are manufactured in jigs and fixtures so that they are strictly interchangeable. All gears are made of steel and pack-hardened so that they possess the required durability to give satisfactory service. The pump is made with various sizes of bolting flanges to meet the requirements of different conditions.

Universal Test Indicator: Johnson & Miller, 42 Murray St., New York City. An instrument in which the contact point can be turned to any desired position in relation to the shank in order to facilitate taking readings on a wide range of work. A friction device protects the contact point from being damaged, because if the work is jammed or pressed too hard against the point the latter swings away.

Forced-feed Lubricator: Madison-Kipp Lubricator Co., Madison, Wis. A valveless forced-feed lubricator, designed in such a way that the supply of oil to each bearing can be accurately regulated without loss. Oil is delivered to all bearings from a common reservoir, and all important parts of the lubricator are entirely visible. The feed pipe delivering oil to each bearing has independent adjustment.

Bench Filing and Hacksaw Machine: Extensive Mfg. Co., 90 West St., New York City. A combination hacksaw and filing machine intended for handling those classes of work which are sometimes done by drilling and hand filing. The machine is particularly adapted for die work, although it can also be used to advantage for filing out gages and templets, and for various other operations of a similar nature.

Detachable I-beam Trolley: Chisholm & Moore Mfg. Co., Cleveland, Ohio. This trolley is designed for use on tracks that have no open end, and it is constructed in such a way that it may be quickly placed on the track or removed. This feature is provided by having a hinge at the bottom of the trolley which enables the wheels to be spread so that they may be passed over the lower flange of the I-beam.

Multiple Keyseat Miller: National Machine Tool Co., Cincinnati, Ohio. A tool which has been developed from the regular type of keyseat miller made by this company. The point of difference consists of the addition of a special guide used in connection with the regular guide to obtain the correct spacing for multiple keyways or splines. These tools are made to mill double, triple or quadruple keyseats.

Shell Coating Machine: Spray Engineering Co., Boston, Mass. A painting machine designed for applying an outside coating to shrapnel and high-explosive shells. The machine consists of a table carried by a steel frame, and the operating mechanism is located beneath the table top. The machine may be used for applying such coating materials as varnish, asphaltum, paint, and various special compounds.

Motor-driven Tapping Machine: Poese Machinery & Mfg. Co., Cleveland, Ohio. This company has recently added to its line of automatic tapping machines a tool equipped with individual electric motor drive. This is the automatic tapping and countersinking machine of this company's manufacture provided with a bracket on the column, on which the driving motor is mounted and geared direct to the machine.

Quick-acting Vise: Fisher & Norris, Trenton, N. J. A quick-acting vise which is operated by a foot treadle so that the operator has both hands at liberty for inserting work in the vise and removing it when finished. This is a particularly convenient feature when handling heavy work, as the operator is able to lift the piece in position between the jaws and tighten the vise without requiring the assistance of a helper.

Portable Crane: Brown Hoisting Machinery Co., Cleveland, Ohio. A portable floor crane constructed entirely of steel so that ample strength is provided without making the crane too heavy to be easily handled. A wide wheel-base is provided to allow side pressure without danger of tipping, and the overhead reach is ample for all ordinary requirements. The crane is built in two sizes having capacities of 1½ and 3 tons, respectively.

Electric Shop Truck: Buda Co., Chicago, Ill. A worm-driven storage battery truck on which the transmission mechanism constitutes a simple unit with all wearing parts running in oil. The brake and circuit breaker are operated by a foot-treadle. In driving the truck the operator is only required to depress the treadle to make the circuit and release the brake, these two functions being performed simultaneously.

Tap Driving Chuck: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A tap driving chuck made from a single piece of hardened steel. This chuck is said to be capable of driving a tap of any given size and gives satisfactory service in extreme cases where the variation in the diameter of the shank is as great as 1/32 inch. The tap is held by the body of the shank and does not depend on the square to make it run true.

Storage Battery Truck: Automatic Transportation Co., Buffalo, N. Y. An electric storage battery truck provided with geared drive and a platform that may be raised and lowered by electric power. This truck is particularly adapted for use in machine shops, manufacturing plants and other places where there is a great amount of trucking to be done. It is intended for use in connection with loading platforms on which the work is placed preparatory to moving it.

Driving Wheel Press: Southwark Foundry & Machine Co., Philadelphia, Pa. A 600-ton driving wheel press, the principal dimensions of which are as follows: Vertical space between tie bars, 96 inches; clearance between ram and resistance post, 9 inches; width of opening in resistance post, 14 inches. The press is equipped with a triple plunger air pump connected to a filling supply tank which delivers air at a pressure of 80 pounds per square inch. This press may be equipped with either belt or individual motor drive.

Hand Miller: Standard Engineering Works, Pawtucket, R. I. A hand miller with a box type knee designed to provide rigidity and afford protection for the vertical adjusting screw, thrust bearings and bevel gears. Feed weights are provided to be hung on the handle. The general design and construction follow standard practice in the building of machines of this type. The table can be brought level with the center of the spindle. The hand-lever provides a table feed of 6 inches, and the crank furnishes a feed motion of 14 inches.

Automatic Pipe Wrench: Craftsman Tool Co., Conneaut, Ohio. The automatic adjustment of this wrench is obtained from a hardened steel disk which carries pinions that mesh with a rack on the body of the wrench. The disk, which is the adjustable wrench jaw, is run up into contact with the work, and when the wrench is in use, the tendency of the disk to slip over the work results in turning the pinions, which drives the movable jaw into more intimate contact. The face of this disk or jaw is serrated to give it a secure grip on the work.

Roller Bearing: George Automatic Roller Bearing Co., Winton Place, Cincinnati, Ohio. A line of roller bearings which are capable of carrying an end thrust equal to 50 per cent of the rated radial capacity. The design of these bearings includes several features which represent a departure from standard practice. The tapered rollers are held in pressed steel retainers, and spacing of the rollers is provided for by means of hardened steel balls which engage formed shoulders at the ends of the rollers. This arrangement reduces friction losses to a point where they are practically negligible.

Hydraulic Drawing Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A machine developed for use in drawing the casing of the Prest-O-Lite dissolved acetylene cylinders. The press has a total capacity of 800 tons and is of the inverted type, all the cylinders being located in the head. Between the movable platen and the base there is a plain ring with babbitted bearings which work on the strain-rods. This is called the blank holder and during the initial drawing operation it grips and holds the disks of steel in place in the circular recess in the stationary platen. The lower platen has a hole through its center with a large recess at the top for receiving the female cupping die through which the steel disk is forced.

Turret Screw Machine: Southworth Machine Co., Portland, Me. A hand screw machine provided with a plain head, automatic chuck, bar feed and hand longitudinal feed to the cut-off. The head and bed are cast integral to provide maximum rigidity. The automatic chuck and bar feed are operated by a long lever in front of the head, giving ample leverage for closing the chuck. The turret has six holes and is adapted for holding tools with or without shanks; bolt holes are provided for securing the tools to the faces of the turret. Independent adjustable stops operate automatically for each position of the turret, and these are readily adjusted for the length of each cut. Tapered gibs fitted the whole length of the saddle on each side provide means of making transverse adjustment of the slide. The cut-off saddle is constructed to maintain the alignment by providing a narrow guide and taper adjusting gib. Manning, Maxwell & Moore, 119 West 40th St., New York City, have the selling agency for this machine.

* * *

In the article "Broaching Square Taper Holes in a Brake Lever" appearing on page 474 of the February number of MACHINERY, it was stated that a J. N. Lapointe broaching machine was used. This was an error, as the machine used was made by the Lapointe Machine Tool Co., Hudson, Mass.

OXY-ACETYLENE WELDED PIPE CONNECTIONS

The rapid extension of the use of the oxy-acetylene blowpipe for welding pipe connections and the possibilities of still further adaptations in the future, give particular interest at this time to figures on the cost and efficiency of connections made by this process as compared with those of screwed connections.

During the spring of 1915 some experiments were conducted at the University of Kansas, which had for their purpose the determination of the strength of welded pipe connections. The pipe welds were compared with screwed connections of equal size and with the original pipe material. The detail work of these experiments was performed by three senior students in mechanical engineering under the direction and supervision of F. H. Sibley, director of the Fowler shops of the University.

The specimens were furnished by the Oxweld Acetylene Co. of Chicago. The samples were cut from standard weight "National" black steel pipe, were from the same stock, and hence presumably of uniform quality. The specimens included two pieces of the original pipe, four butt welds, two connections made with malleable iron screwed couplings, three welded tees and two tees made up with malleable iron screwed fittings. The length of the straight samples was 18 inches. The pieces for the butt welds were cut at an angle of about 60 degrees in a pipe cutting machine to give the necessary V groove for welding. The tees were made with an 18-inch run and a 15-inch outlet, the tee welds being made by cutting a hole in the run and butting the outlet against the outside of the run. All the connections were made by the company's operators.

TABLE I. RELATIVE STRENGTH OF WELDED AND SCREWED PIPE CONNECTIONS

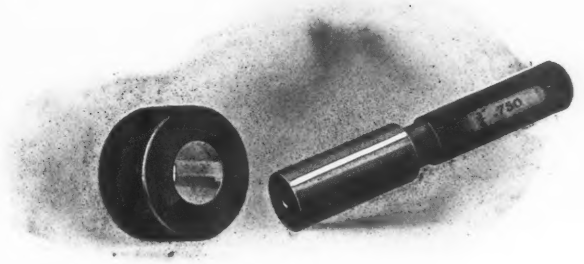
Pipe Size (Inches)	Average Maximum Load		Relative Strength of Welded to Screwed Connection (Per cent)
	Welded Connection (Pounds)	Screwed Connection (Pounds)	
TENSION TESTS OF BUTT WELDS AND COUPLINGS			
½	10,222	9,040	113
¾	21,367	13,835	154
1	28,330	17,230	164
1½	43,975	31,270	140
COMPRESSION TESTS OF BUTT WELDS AND COUPLINGS			
2	72,500	58,150	125
TENSION TESTS OF WELDED AND SCREWED TEES			
½	12,903	8,723	148
¾	19,763	12,303	160
1	30,007	17,550	171

Machinery

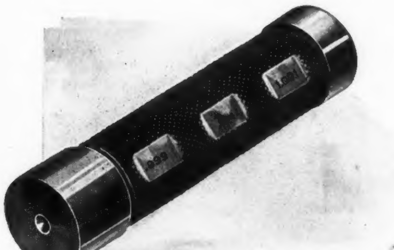
The straight samples of ½-, ¾-, 1-, and 1½-inch pipe were fitted with plugs in the ends to prevent crushing in by the jaws of the testing machine, and were then tested in tension by the usual method. The 2-inch straight samples were cut off square to lengths of 5 inches and tested in compression. For the tee welds a holder was made to fit the run of the tee at each side of the joint. The end of the holder was then placed in the upper jaws of the testing machine, the outlet of the tee was held in the lower jaws, and the sample was tested in tension.

The action of the welded connections under tension was very much like that of the original pipe specimens. Some of the specimens broke outside of the weld and some broke in the weld. All the screwed connections broke right at the last thread in the fitting. The 2-inch pipe samples tested in compression bulged out on each side of the weld, split along the seam in the pipe as far as the butt weld, which held without splitting. One of the screwed fittings sheared the threads and telescoped, and the other bulged outside of the fitting. In most cases the welded tee connections broke in the outlet and at some distance from the weld. All the screwed tee fittings broke in the casting.

Keep Your Work Accurate Within Close Limits



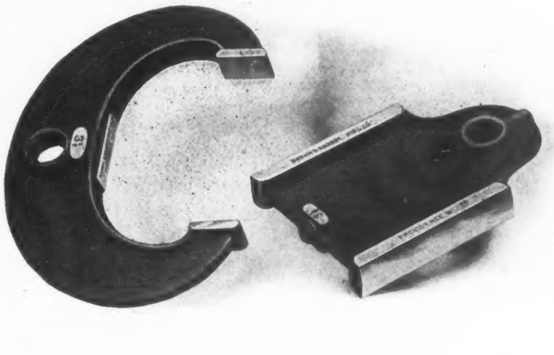
Establish a definite standard of accuracy and hold your work to it. It is not difficult. A little attention and equipment are all that are necessary. And it pays in the end. When different parts are made in various departments and afterwards assembled it is worth a little attention to have those parts reach the assembling benches in a condition that eliminates waste of time and material through the necessity of fitting. Hence, accurate standard measurements are essential and you can maintain them with maximum efficiency and minimum expense by using



Brown & Sharpe Standard Gauges—the Dependable and Economical Way

These Gauges are dependable because they are made of high quality tool steel carefully hardened and accurately lapped to size within the finest possible limits. They are economical because they make it possible for a workman to test every piece positively and quickly. The slightest deviation from a pre-determined standard can be detected and the error promptly corrected. Of course pieces could be checked with a caliper but there is a big advantage in using B. & S. Gauges in producing interchangeable parts. This applies both for positive results and greater speed.

Our line of Standard Gauges is unusually complete and meets a broad range of requirements. They are listed in our No. 26 catalog. Have you a copy? Or if you need special sizes we will gladly quote on your requirements.



Providence, R. I., U. S. A.

CANADIAN AGENTS: The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. Johns, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfort a.M., Germany; V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, Petrograd, Russia; Fenwick, Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila. P. I.

The results of the tension and compression tests of the specimens of butt welded pipe, unwelded pipe, and malleable iron screwed pipe couplings show that the elastic limit of the welded specimens was practically the same as the unwelded pipe. The screwed coupling specimens broke without elongating because of the reduced cross-sectional area at the threads, and so have no elastic limit. The higher strength of the welded connections is at once appreciated from the data given in Table I.

Those who are concerned with the comparative cost of making pipe connections by the two methods will be interested in Table II. The cost of oxygen at the present time varies from 1½ to 2 cents per cubic foot in different parts of the country. The price of 2 cents which has been used in computing these tables is therefore very conservative. The cost of acetylene at 2 cents per cubic foot is the price if supplied in tanks. If the acetylene were generated as used, the cost would be reduced to a little less than 1 cent per cubic foot.

TABLE II. COST OF PIPE CONNECTIONS

Pipe Size, Inches	½	¾	1	1½	2	3	4
WELDED BUTT JOINTS							
Time, minutes	3.00	3.50	4.00	5.00	6.00	10.00	15.00
Oxygen, cubic feet	0.28	0.43	0.76	0.95	1.51	2.51	4.76
Acetylene, cubic feet	0.23	0.41	0.74	0.92	1.47	2.44	4.43
Welding wire, ounces	0.08	0.15	0.20	0.30	0.50	1.60	4.00
COST							
Labor, at 30 cents	$.0150	$.0175	$.0200	$.0250	$.0300	$.0500	$.0750
Oxygen, at 2 cents	.0056	.0086	.0152	.0190	.0302	.0502	.0952
Acetylene, at 2 cents	.0046	.0082	.0148	.0184	.0294	.0488	.0886
Welding wire, at 12 cents	.0006	.0011	.0015	.0023	.0038	.0120	.0300
Total cost	$0.0258	$0.0354	$0.0515	$0.0647	$0.0934	$0.1610	$0.2888
SCREWED COUPLINGS							
Cost of fitting	$0.02	$0.03	$0.04	$0.08	$0.11	$0.27	$0.45
Cost of making up joint	0.02	0.02	0.03	0.03	0.04	0.05	0.07
Total cost	$0.04	$0.05	0.07	$0.11	$0.15	$0.32	$0.52
WELDED TEE JOINTS							
Time, minutes	4.50	5.00	5.50	7.00	9.00	16.00	22.00
Oxygen, cubic feet	0.41	0.61	1.05	1.34	2.26	4.02	6.98
Acetylene, cubic feet	0.35	0.59	1.01	1.29	2.20	3.88	6.50
Welding wire, ounces	0.20	0.40	0.60	1.00	1.40	5.40	9.50
COST							
Labor, at 30 cents	$.0225	$.0250	$.0275	$.0350	$.0450	$.0800	$.1100
Oxygen, at 2 cents	.0082	.0122	.0210	.0268	.0452	.0804	.1396
Acetylene, at 2 cents	.0070	.0118	.0202	.0258	.0440	.0776	.1300
Welding wire, at 12 cents	.0015	.0030	.0045	.0075	.0105	.0405	.0713
Total cost	$0.0392	$0.0520	$0.0732	$0.0951	$0.1447	$0.2785	$0.4509
SCREWED TEES							
Cost of fitting	$0.04	$0.05	$0.08	$0.14	$0.18	$0.51	$1.02
Cost of making up joint	0.03	0.03	0.04	0.04	0.05	0.06	0.09
Total cost	$0.07	$0.08	$0.12	$0.18	$0.23	$0.57	$1.11

Machinery

The cost of the fitting is the principal item in the screwed connections. In most cases the cost of the welded joint is less than the cost of the fitting. As the pipe sizes increase, the lower cost of the welded joint is even more marked. The conclusions that may be drawn from these tests point to the following facts:

> The cost of the welded connections is less than the cost of the screwed connections. The larger the pipe size the greater is the difference.
>
> The time required to make up the screwed connections is about the same as that required to make up the welded connections.
>
> The strength of a welded pipe connection is practically the same as that of an unwelded pipe. By building up the weld it can be made as strong as or even stronger than the rest of the pipe.
>
> The elasticity of the pipe is not much affected by welding.
>
> **The strength of the welded pipe connections is greater than that of malleable iron screwed fittings. The strength of the welded specimens was from 113 to 171 per cent of that of the screwed connections.**

CUSTOMS INFORMATION

NIPPERS AND PLIERS DUTY—MACHINE TOOLS DEFINED—RELATION OF FINISH TO ULTIMATE CONDITION

BY JULES CHOPAK, JR.*

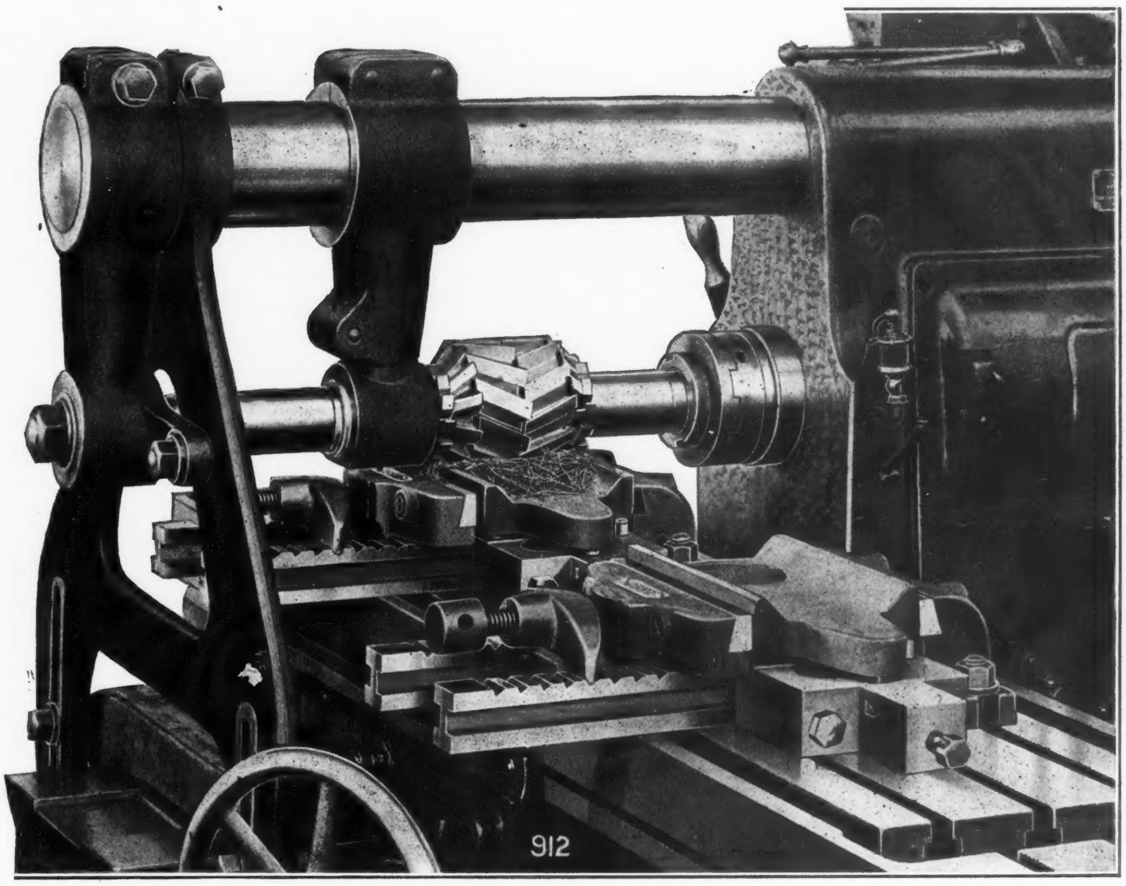
A decision of the Treasury Department was reported in the February number of MACHINERY, which held that dental tweezers, when imported, are dutiable at 20 per cent and not at 30 per cent as nippers and pliers of all kinds. Since then the United States Court of Customs Appeals at Washington, the final court in such matters, has clearly confirmed this ruling by deciding that various surgical forceps and instruments generally are in no wise nippers and pliers. The decision reverses other decisions previously made by the Board of General Appraisers, holding articles in general having two lever handles working on a pivot and which operate two cutting, gripping or pinching jaws or blades to be nippers and pliers.

The conclusion of the Court was reached by considering several matters which may be briefly stated as follows: In the general understanding of "pliers" and "nippers," dental and obstetrical apparatus are in no sense included. When Congress revised paragraph 168, Act of 1909, the prototype of the present nipper and plier paragraph now 166, it specifically refused to include "surgical and dental instruments or parts thereof" for dutiable purposes with nippers and pliers. Furthermore, such articles are better termed "forceps," according to the authority of Knight's American Mechanical Dictionary, than "nippers and pliers."

The following are customs protests now before the Board of United States General Appraisers, wherein importers have objected to the higher rates exacted by the government. Persons interested may assist in settling by giving such testimony as is of value.

> *Protest:* Power-driven machine for cleaning reeds for looms. *Assessed:* 20 per cent under paragraph 167 as a manufacture of metal. *Claim:* 15 per cent under paragraph 165 as a machine tool.

* Customs Lawyer, 29 Broadway, New York City.



This No. 4 High Power Cincinnati Miller

is equipped with two of our ALL STEEL VISES. They hold these rough iron castings securely enough for this cut, 7″ wide, 3-16″ deep, feeding 12.6″ per minute. The total time for two cuts, roughing and finishing, including two chuckings, is 6 minutes. The best previous time was 17.3 minutes.

Here is a machine that can take the cut, and a vise that can hold the piece. That's a combination that will pay you.

Ask us for details.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

The term "machine tools" has been defined for tariff purposes to apply to such as are operated by power other than hand, and which work on metal, wood or stone. (Gallagher v. U. S. 3 Ct. Customs Appeal, 520) unless wholesale dealers have given the term another meaning. This has been done, as the Board of General Appraisers found in T. W. 34,413. From the trade testimony introduced, the Board defined "machine tools" to be machines driven by other than hand power, working upon metal and employing in their operations cutting tools. It follows that the lower claim of 15 per cent is without merit, since the machine does not cut metal in its operation.

Protest: A combination of a thirteen-needle embroidery machine and a card punching attachment for cutting out the design of the pattern. *Assessed:* 25 per cent under paragraph 165 as an embroidery machine. *Claim:* 20 per cent under paragraph 167 as a manufacture of metal.

The question here is whether the addition of the card punching attachment changes the character of the machine from that of an "embroidery machine." If so, the lower duty will be applicable since there is no other classification in the tariff to be taken. The question turns largely on what are generally considered embroidery machines in the trade. Such combinations as this might very well be embroidery machines of a special type. If, however, the attachment is such as to make a new article not in any sense an "embroidery machine," then the assessment as such cannot stand.

Protest: Circular saw plates containing alloys. *Assessed:* 15 per cent under paragraph 110 as steels by whatever process made, containing alloys. *Claim:* 8 per cent under paragraph 110 as steel sheets not containing alloy, and 12 per cent under paragraph 105 as saw plates cut or sheared to shape or otherwise.

From the government description of the articles, it appears that they contain alloys. Assuming that to be a fact, the 8 per cent claim is at once disposed of. The issue is then narrowed to the provision for "steels containing alloys" as against "saw plates cut or sheared to shape or otherwise." Under well settled customs rules, the classification which is narrower and more specific in its terms is most applicable. Furthermore, a provision which mentions an article by its name usually takes precedence. Applying these rules to this case it would seem that the correct duty should be 12 per cent and not 15 per cent as charged by the government. The merchandise is admitted to be "saw plates" which the 12 per cent classification especially mentions. The classification for "steels containing alloys" takes in a large variety of steel articles in no sense saw plates, while saw plates are limited to a certain class of goods, whose character and use are limited whether or not alloys are used in their manufacture.

Protest: Strainers composed of metal and wire. *Assessed:* 20 per cent under paragraph 167 as a manufacture of metal, metal being the chief value. *Claim:* 15 per cent under paragraph 114 as articles manufactured from wire.

Paragraph 114 exacts 15 per cent duty on "articles manufactured wholly or in chief value of any wire provided for in this section." Under a decision of the Washington Customs courts made May 18, 1915, these strainers would seem to be properly dutiable here. In that case, the merchandise was heavy wire bent in V form as staples. The court held the above quoted classification as controlling. The case would appear to be authority here. On the other hand, the government's assessment is under a clause for metal articles not covered by any other tariff provision, known as the basket or catch-all clause, taking only such articles as fail to find an enumeration elsewhere.

Protest: Steel sheets rolled to such an extent as to constitute planished steel. *Assessed:* 15 per cent under paragraph 109 as planished steel. *Claim:* 8 per cent under paragraph 110 as sheets made by the Siemens-Martin process.

The question raised by this protest is one of fact, namely, if the sheets in their condition as imported, are planished. It has been held as to cold-rolled sheets having a polish incidental to the rolling, that if it was not intentionally done and the polish served no useful purpose but was destroyed in the future operations of manufacture or was not available when a polished surface was ultimately desired that such sheets were not "polished." This may be the rule applicable to these sheets. If not, then the 15 per cent duty must stand as assessed.

FOREIGN TRADE OPPORTUNITIES

A REVIEW OF DEVELOPMENTS ABROAD OF INTEREST TO MANUFACTURERS

At a recent meeting of New York bankers it was said that as the war reaches its climax the nations involved will strain every resource and direct every effort toward the business of winning. This means that productive industries will be even more crippled than at present. Of necessity, therefore, the former customers of the European nations will be obliged to turn to the United States. This is shown by the increase of exports in 1915, when the trade with Europe was doubled and that with Africa, South America, and Asia was increased one-half; an increase not wholly due to munitions of war.

George H. Pickerell, American consul at Para, Brazil, reports that the people in Brazil are taking an immense amount of interest in everything North American, and cannot understand why the people there are not reciprocating to a greater degree. The feeling toward the United States is of the best, and the prospects, on account of the conditions brought about by the European war, were never more favorable for United States trade extension than at this moment. India and Ceylon importers also are eagerly seeking American trade because of their failure to obtain goods in Great Britain.

Russia's dependence upon Germany for goods of all kinds and the opening there for other nations is the subject of an interesting article in *Engineering* (London) which says that there is an almost unlimited demand in Russia for almost all products of the iron industry, and people seem agreed that for a long series of years Russia will be unable herself to cover her requirements, and will have to import a great quantity of goods from abroad. The conditions, however, vary much, both as regards the different classes of goods and the different parts of the vast empire. Generally, it may be said that the finer a machine is, and the more difficult to produce, the greater the chance of exporting it with advantage to the Russian market. On account of the duty, heavy articles and the more simple ones are likely to prove unremunerative, and for some, especially such as are also produced in Russia, the duty is simply prohibitive, reaching or even exceeding, the selling price within Russia of the article in question. Generally speaking, competition is keener in the Western ports, which are nearer Germany.

Internal-combustion motors are certain of a large demand when constructed for using Russian unrefined petroleum, especially in places such as Moscow, Rostoff, Odessa, Kieff, etc., in spite of there being several Russian factories in this branch. There are several manufactories of wood-working machines in the country; still the importation is considerable. Machine tools are for the present in strong demand, and will, no doubt, also meet with a large sale after the war. Electrical apparatus and appliances have hitherto been almost exclusively imported from Germany. The articles under this head are generally imported in unassembled parts, on account of the duty. Several German and Swedish factories have imported a fair number of dynamos and electric motors, but large quantities are made at the Russian manufactories, which have been fully employed during the war. Light motors run at high speeds meet with the readiest sale. Telephones and telegraph material are imported on a large scale. There are some large Swedish telephone exchanges in Russia.

Russians are accustomed to having prices quoted delivered in Russia, duty paid. In the case of more important machinery, purchases may be made F. O. B. shipping port, and during the war this system has had to be generally adopted.

It is quite customary, also, in dealing with very substantial firms, for a credit of six months, twelve months, or even more, to be allowed. Even the Zemstvo organizations want from three to six months credit. Russian wholesale merchants and large commercial houses give long credits, two years or more. Not infrequently, however, payment of one-third of the amount may be obtained on delivery, and as a rule acceptances may be had for the balance of the invoice. For agricultural machinery, the due dates are often arranged to fall immediately after the harvest; during years with unfavorable harvests the seller must be prepared to prolong

such bills for another twelve months. The saving deposits in the banks of Russia, during the year ending September, 1915, increased $288,100,000, making the total saving deposits of the nation $1,163,100,000. C. F. Just, the Canadian special trade commissioner, says:

It is doubtful whether any conceivable scale of waste and destruction of life in the present war, on the side of Russia, will affect the country's economic position for any appreciable period, if the past be a reliable guide in such matters. She has tried with impunity, economic experiments which would have seriously affected most other countries. Wars and political and social upheavals have seemingly had but little effect. Her national resources are very great and of infinite variety and her present population of 171,000,000, however backward and inefficient, is being slowly raised and educated.

There is to be found in Russia, therefore, the unusual conditions of great opportunities for industrial enterprise for which the consuming power is at hand, side by side with opportunities for imports on an extensive scale, with the certainty that the former will rather stimulate than retard the growth of the latter, both in variety and extent; for with the slightest rise in the standard of comfort of such a large population the home industries can hardly expect to meet the demand, at least not for a number of years.

The prospects for immediate trade in various foreign countries are good. Finnish Lapland is now planning to develop its vast deposits of iron ore, which are equal, if not superior, to the deposits of Sweden and Norway; the plans include the building of a railway having a total length of nearly 300 miles. Siam, Bolivia, Chile, and Colombia, too, are planning extensive railway building; while the new Chosen budget gives $4,182,415 for the construction and improvement of its railways, and Russia has recently made great purchases in railway material. The Braden Copper Co. is spending $10,000,000 for steel and machinery for its property at Rancagua, Chile.

The British Board of Trade is confidently stating that Great Britain will hereafter be the world's greatest commercial agent, and British agents are even now seeking to foster such conditions in all countries as will be most favorable to this need. France is seeking to build up a merchant marine and has changed its patent laws so that she now forbids the working in France of patents and trade-marks owned by subjects of *resortissants* of Germany and Austria-Hungary (called here, for convenience, "alien enemies") by those subjects or *resortissants* or their agents. Transfers of or licenses under patents and trade-marks effected by alien enemies are valid only if the transferee can prove that the transfer was made *bona fide* and before the declaration of war, or if a board specially appointed consider the transfer to be in the public interest or for national defense. Moreover, in any case, the state may itself take over the working of patents owned by "alien enemies." The new law provides that patents may not be granted during the war to "alien enemies," but all priority rights under the International Convention are to be kept alive in the case of applicants whose states grant similar advantages to France. Other nations, too, are preparing to seek the world's commerce especially by means of favored-nation treaties. Canada and Australia have already passed tariff laws destined to place American manufacturers at a disadvantage, but United States consuls and other persons familiar with various countries are very urgent that present opportunities to introduce American goods be taken advantage of, claiming that the merits of these goods will secure a large share for them in the later trade. D. E. J.

* * *

PERMANENT MACHINERY HALL

A machinery hall has been established on the fifth floor of the Grand Central Palace, Lexington Ave., 46th to 47th Sts., New York City, for the permanent exhibition of machinery in operation and for demonstration. The area available is 52,000 square feet and it will be sub-divided to suit individual exhibitors' needs. Exhibitors may also rent offices in the building, and electric lighting and all needed facilities will be provided to cover the exhibitors' needs. In the exhibitors' absence, attendants will be provided to hand out literature and otherwise, so far as may be practicable, to represent them. Further information will be furnished by H. D. Benedict, manager of the Merchants & Manufacturers Exchange, Grand Central Palace, New York City.

PERSONALS

A. B. Hazzard has taken the position of engineer of equipment with the Amalgamated Machinery Co., 71 Broadway, New York City.

George B. Morris has taken a position with the Curtiss Aeroplane Co., Buffalo, N. Y., and will have charge of the special organization and production routing work, advising departments, etc.

Charles W. Burrage, formerly of the instructing staff of the Massachusetts Institute of Technology and associated with F. W. Dodge Co. in connection with the preparation of *Sweet's Index*, has joined the staff of Walter B. Snow, Boston, Mass.

Emil Gairing, formerly general superintendent of the Baker & R. & L. Electric Vehicle Co., Cleveland, Ohio, has obtained an interest in the Eclipse Interchangeable Counterbore Co., Detroit, Mich., and has been made vice-president and manager of production.

Frederick E. Koehler, formerly commercial manager of the Central Illinois Utilities Co., has secured an interest in the business of the Racine Tool & Machine Co., Racine, Wis., manufacturer of high-speed metal cutting machines. Mr. Koehler has been made vice-president and acting manager. J. M. Jones, president and general manager, who still retains his interest, is spending the winter in Florida.

* * *

OBITUARIES

Alexander Saunders, president of D. Saunders' Sons, Inc., Yonkers, N. Y., died at his home in Yonkers, February 1, aged seventy-eight years.

John W. Hill, mechanical engineer and sales manager in charge of the Detroit office of the Bantam Anti-Friction Co., Bantam, Conn., died suddenly at his home in Detroit, February 12. Mr. Hill was a member of the American Society of Mechanical Engineers and the Society of Automobile Engineers, and ranked high as a tool designer.

Readers will hear with deep regret of the death of Charles Churchill, head of Charles Churchill & Co., Ltd., London, the oldest concern importing American machine tools into Great Britain. Mr. Churchill died February 14, following the death of his son, Charles Henry Churchill, who died February 8. The business was established in 1865, and besides the London house has four branches in Birmingham, Glasgow, Manchester and Newcastle-on-Tyne. An extended notice will appear later.

Christopher C. Bradley, president of C. C. Bradley & Son, Inc., manufacturers of Bradley power hammers and forgers, died at his home in Syracuse, January 29, aged eighty-one years. Mr. Bradley was born in Syracuse. A few years previous to his birth his father established a foundry under the firm name of Alexander, Bradley & Co., where salt kettles were cast. Mr. Bradley became associated with his father in the foundry business, and as the salt business fell off the firm began the manufacture of farm implements and carriage hardware. In 1855 the firm of C. C. Bradley & Son was established. C. C. Bradley, Jr., entered the business in 1894, and since that time the firm has manufactured power hammers and carriage hardware. Mr. Bradley retired in 1911.

Richard S. Bryant, factory manager of the Standard Welding Co., Cleveland, Ohio, died of cancer at the Post-Graduate Hospital, New York City, January 24, aged forty-six years. Mr. Bryant was widely known as an authority on automobile rims and had invented a number of special types during his career. Most of the detachable rims now in use were designed by him while with the Standard Welding Co. He was the first to design a quick-detachable rim, a type still considerably used. He organized the Bryant Rim Co. of Columbus, Ohio, which was later bought out by the Diamond Rubber Co. of Akron. The good-will and patents of his Columbus Co. were turned in later to the United Rim Co. of Akron, which was a holding company for several rim patents owned by the large rubber companies. He was then made consulting engineer of the United Rim Co. Later he was employed by the Standard Welding Co. as consulting engineer, and quite recently was made its factory manager.

Thomas J. Moore, for the past eight years sales manager of the Philadelphia branch of the Halcomb Steel Co., died at Atlantic City, February 6, after a brief illness, aged fifty-seven years. Mr. Moore was born in Douglas, Isle of Man, and came to America in 1879 after receiving a good education and serving an apprenticeship in the Crewe shops of the London & Northwestern Railway. He held responsible positions successively with the Baldwin Locomotive Works; Pennsylvania R. R. shops at Altoona; Union Switch & Signal Co.; and the New York Shipbuilding Co. He entered the employ of the Halcomb Steel Co. January 1, 1907, as salesman, and within two years became manager of the Philadelphia office, and served with marked success until his death. He leaves a widow and three children, one of whom, Thomas J. Moore, Jr., succeeds him as acting manager of sales.

SOCIETIES, SCHOOLS AND COLLEGES

Grove City College, Grove City, Pa. Catalogue 1915 containing calendar and courses of study for the year 1915-1916.

Stevens Institute of Technology, Hoboken, N. J. Annual catalogue, January-July, 1916, and September, 1916,-July, 1917.

Vocational High School, New London, Conn. Souvenir booklet showing views in the various departments of the school and some of the work done by the students.

American Museum of Safety, 14-18 W. 24th St., New York City. Special bulletin on the award of the Scientific American medal for 1915 to Elmer A. Sperry for his gyroscope compass and stabilizer. The bulletin contains an interesting article on the gyroscope as a safety device, giving the curves showing the performance of the "active" type of gyroscope in stabilizing a pendulum ship model.

Pratt Institute, Brooklyn, N. Y., will open the shops, laboratories and drawing rooms of the school of science and technology to the public on Wednesday evening, March 8, giving an opportunity to all persons interested in industrial education to observe the students at work in the various courses, and to inspect the results and methods as well as the equipment and general facilities for conducting industrial training.

NEW BOOKS AND PAMPHLETS

Examples in Magnetism. By F. E. Austin. 90 pages, 4¾ by 7½ inches. 27 illustrations. Bound in flexible leather. Published by the author, Hanover, N. H. Price, $1.10.

This work by Prof. Austin is treated in the same general style as his "Examples in Alternating Currents," "How to Make Low-pressure Transformers," and "Directions for Designing, Making and Operating High-pressure Transformers." It is intended for students of physics and electrical engineering who are pursuing regular college courses or studying at home, being expressed in a simple style that should be well within the comprehension of every ordinary high-school pupil. It is not merely a book of problems, but a compilation of carefully selected examples that illustrate fundamental principles and embody data useful in actual electrical work.

Mechanical Drafting. By Charles B. Howe. 147 pages, 9 by 10¾ inches. 166 illustrations and 38 plates. Published by John Wiley & Sons, Inc., New York City. Price, $1.75.

This work on mechanical drawing is not intended to be a manual of self-instruction, but is offered rather as an assistant to the teacher to help him in his presentation of the subject, and to supply the conventions, data and problem sheets. The work is comprehensive, dealing with machine drawing, architectural drawing and typical drawing. The contents by chapters follow: Materials and Instruments; Principles of Drafting; Geometry of Drawing; Working Drawings; Machine Drawing; Plan Drawing; Plot and Map Drawing; Pictorial Representation and Sketching; Blueprinting. The work contains many drawings and halftone illustrations of mechanical parts, buildings, etc.

Financing an Enterprise. By Francis Cooper. 524 pages, 5½ by 8 inches. Published by the Ronald Press, New York City. Price, $3.

This book is a manual of information and suggestion for promoters, investors and business men generally. The author observes that the principles of finance do not change, but their application does. The book was first published in 1906, and has now passed into the fourth edition. The purpose of the work, as announced in the first edition, is to set forth the principles of financing business enterprises as clearly as may be, to point out the common mistakes and suggest the best methods of procedure, and to serve generally as a manual of information. The chapter topics are: The Enterprise; Investigation of an Enterprise; Protection of an Enterprise; Capitalization of an Enterprise; Presentation of an Enterprise; and Special Features of Promotion.

Automobile Repairing Made Easy. By Victor W. Page. 1060 pages, 5¼ by 8 inches. 500 illustrations. Published by the Norman W. Henley Publishing Co., New York City. Price, $3.

This book is remarkable for its range, number of illustrations and generally satisfactory treatment of the many varied topics discussed. It describes approved methods of repairing all types of gasoline automobiles, shows late developments based on wide actual repair experience and includes electric starting and lighting system instructions, matter on oxy-acetylene welding, tire repairing, engine and ignition timing, etc. The rapid growth of the automobile industry has resulted in the establishment of many automobile repair shops, and the demand for mechanics skilled in the art of caring for, adjusting and repairing automobiles, has exceeded the supply. This book should meet a general demand for specific instruction by those who have some general mechanical skill and experience. The contents by chapter heads are as follows: The Automobile Repair Shop; Small Tool Equipment for Repair Shops; Overhauling the Gasoline Engine; Cooling, Carburetion and Lubricating System Faults; Location and Remedy of Ignition Troubles; Motor Starting and Lighting Systems; Defects in Clutch and Gear-box; Faults in Chassis Components; The Rear Axle and Driving System; Wheels, Rims and Tires; Miscellaneous Repair Processes; Useful Information for Auto Repairmen; Hints and Kinks. The concluding chapter contains mathematical, mechanical, and miscellaneous tables.

NEW CATALOGUES AND CIRCULARS

Turner Machine Co., Danbury, Conn. Bulletin on the Turner Model F automatic vertical turret lathe.

Allis-Chalmers Mfg. Co., Milwaukee, Wis. Catalogue of centrifugal pumps and centrifugal pumping units.

Wright Mfg. Co., Lisbon, Ohio. Catalogue 7 on Wright high-speed steel chain hoists, steel trolleys and hand cranes.

Link-Belt Co., Philadelphia, Pa. Catalogue 250 on Link-Belt wagon and truck loaders for handling coal, coke, stone, sand and similar loose materials.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Booklet 224 on belt- and motor-driven pneumatic compressors, and "Giant" fuel oil and gas engines.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Bulletin 49200 treating of electrical theatrical devices, equipment and accessories.

Fort Wayne Electric Works of General Electric Co., Fort Wayne, Ind. Bulletins 46102 and 46103 on Type H demand indicators and Type M-2 demand indicators, respectively.

Mesta Machine Co., Pittsburg, Pa. Bulletin H descriptive of Mesta blowing engines, equipped with automatic plate valves which eliminate the necessity of making adjustments.

Louis Hanssen's Sons, Davenport, Ia. Catalogue 64 on hardware, factory, mill and contractors' supplies and tools. The book contains 1116 pages, 5¾ by 9 inches, and the index covers 18½ pages.

American Spiral Pipe Works, Chicago, Ill. Bulletin 15-9 illustrating lap welded steel pipe made up in any required length, with diameters from 12 to 72 inches and in thicknesses of from ⅛ to 1¼ inch.

General Electric Co., Schenectady, N. Y., has just issued Bulletin 48017 which refers to the application of electricity in the harvesting of natural ice, and illustrates various motors applicable to this work.

Goodell-Pratt Co., Greenfield, Mass., has issued a little pamphlet entitled "The Story of the Stratton Level," which contains a historical sketch of the origin and development of Stratton levels, and an article on the making of these levels.

Chain Belt Co., Milwaukee, Wis. Supplement to general catalogue 56 containing revised price lists of standard detachable chain belts and various changes in Chabelco steel chain belts. The new H type of riveted chain belt is illustrated on pages 8 and 9.

New Departure Mfg. Co., Bristol, Conn. Leaflets on ball bearing application in vertical spindle wood shaping machine; speed reduction gearing for use with marine steam turbine; ball bearing mounting of cylinder mold shaft; and adjustable cylinder mold bearing mounting.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue D containing descriptive matter on electric monorail man trolleys, hand trolleys, tramrail equipment, transfer cranes, jib cranes, overhead traveling cranes, electric hoists, current collectors and motor-driven trolleys.

Tinius Olsen Testing Machine Co., 500 N. 12th St., Philadelphia, Pa. Catalogue of testing machinery exhibited by the company at the Panama-Pacific International Exposition, comprising a variety of testing machines designed for testing metals, fabrics, rubber, etc.

Vanadium-Alloys Steel Co., First Ave. and Ross St., Pittsburg, Pa., is distributing copies of an article on tungsten mining in Colorado, written by the president of the company, Roy C. McKenna. Anyone may obtain a copy of the article by making application to the company.

Link-Belt Co., Chicago, Ill. Booklet entitled "Insuring the Coal Supply," containing an article that describes various coal storage systems designed to accommodate large supplies of coal so as to eliminate delays in business due to strikes, congested conditions on railways, storms, or other emergencies.

Reliance Engineering & Electric Co., 1056 Ivanhoe Road, Cleveland, Ohio. Bulletin 1013 on the advantages of motor-driven lathes as compared with cone pulley and belt-driven lathes, containing description and specifications of the Reliance all-gear motor drive for application to cone pulley lathes.

D. & W. Fuse Co., Providence, R. I. Catalogue describing the line of Deltabeston wires and insulating materials. Deltabeston wires are covered with asbestos insulation which is claimed to be absolutely fire-proof. All the wires listed in this catalogue are new with the exception of Deltabeston magnet wire.

National Tube Co., Pittsburg, Pa. Booklet entitled "The Whole Kewanee Family," covering the line of Kewanee unions and specialties manufactured by this company. The book contains 72 pages, 5¼ by 7¾ inches, and is printed in three colors. A complete list of the Kewanee specialties is given on page 60.

Strauss & Buegeleisen, 489 5th Ave., New York City. Circular advertising eye protectors made of "Micalite," a substance which has all the properties of celluloid but is incombustible. The protectors are made of clear "Micalite" amber, or combination clear and amber for eliminating the glare from the eyes.

Merchants & Manufacturers Exchange of New York, Lexington Ave., 46th to 47th Sts., New York City. Circular describing the facilities of Machinery Hall that will be opened on the fifth floor of the Grand Central Palace for the permanent exhibition and demonstration of machinery. The available area is 52,000 square feet.

Niles-Bement-Pond Co., 111 Broadway, New York City. Circular 101 illustrating and describing the Niles-Bement-Pond 48-inch car-wheel boring machine; circular 102, describing the Niles center-drive car-wheel lathe; circular 103 on Niles 36-44-inch side-head boring mill; and circular 104 on Niles 90-inch heavy-pattern driving-wheel lathe.

General Electric Co., Schenectady, N. Y. Bulletin 42206 on Curtis steam turbine-generators. The catalogue takes up the general principles and construction of these generators and treats of the advantages of Curtis turbines. Some types of General Electric turbines are shown, as well as some installations of representative Curtis turbines.

Carlisle & Co., 74 Broadway, New York City. Booklet entitled "Tungsten, Its Properties and Uses," describing the characteristics of the metal, uses, sources of supply, etc. An abstract from the United States Geological Survey is included, which gives some interesting facts regarding the physical, chemical and electrical properties of tungsten.

Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. Bulletin 5004 illustrating and describing a 1000-ton hydraulic press for heading brass cartridge cases. Bulletin 5005 illustrating and describing an 800-ton hydraulic drawing press, with examples of work done in drawing dissolved acetylene cylinders for the "Prest-O-Lite" Co.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Bulletin 34 K describing the details of construction of class N-SO fuel oil driven compressors, and their application to the unit system of air power plants. These compressors are made in six standard strokes of 8, 10, 12, 14, 18 and 21 inches, the dimensions, speeds, capacities, etc., being given in the tables.

Cleveland Fabric Belting Co., 1473 W. 110th St., Cleveland, Ohio. Circulars descriptive of the "Clefabco" straight-line belt adjuster for tensioning loose or broken belts. This adjuster is equipped with quick-acting clamps and a positive worm drive, which eliminates slipping. It is made in two styles, for belts from 6 to 12 inches in width and from 16 to 36 inches in width, respectively.

E. C. Atkins & Co., Inc., Indianapolis, Ind. Supplement to catalogue 12, showing new goods and changes since the issuance of this catalogue. This supplement contains data on Atkins band saws, one-man saws, nests of saws, pruning saws, trowels, web saw frames, butcher saws, spoke shave, protectors for hacksaw frames, hand saw jointer, non-breakable hacksaw blades, saw guards, etc.

Wheeler Condenser & Engineering Co., Carteret, N. J. Circular illustrating and describing horizontal centrifugal pumps for condenser circulation, irrigation, drainage, dry docks, and general mill and power plant service, having a two-part divided casing, with suction and discharge nozzles in the lower half. The impeller is of the enclosed double-suction type, protected by labyrinth wearing rings.

Wm. D. Gibson Co., Huron and Kingsbury Sts., Chicago, Ill. Catalogue 5 of compression, torsion, extension and flat springs made from crucible steel, alloy steel, open hearth steel, music wire, phosphor-bronze and brass. The catalogue contains formulas and data on springs of much value to all designers. A large variety of spring ends and shapes are illustrated which also should be of interest and value.

Nash Engineering Co., South Norwalk, Conn. Bulletin 3 describing Nash hydro-turbine air compressors and vacuum pumps of the single-stage type, and containing table of speeds and capacities; bulletin 4 on turbine vacuum and low-pressure boiler feed pumps for return-line heating systems or any work where air or other gases containing large percentages of liquid have to be handled under a vacuum.

Edwin Harrington Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. Catalogue L descriptive of Harrington chain hoists, made in three styles: the "Peerless" for fast speed and high efficiency, the "Screw" for simplicity and rough usage, and the "Differential" for occasional use not demanding high efficiency. Harrington travelers are also described; these can be obtained alone or combined with Harrington hoists.

Crescent Tool Co., Jamestown, N. Y. Circular describing the display board for the "Hamr-Handl" screwdrivers which are being placed on the market. This display easel is made of heavy cardboard 10 by 13 inches in size and weighs 2¼ pounds mounted with the tools. It is supplied to dealers without charge with an assortment consisting of one-quarter dozen each of the 4-inch, 5-inch, and 6-inch screwdrivers, and fifty circulars describing the tools.

Imperial Brass Mfg. Co., 1224 W. Harrison St., Chicago, Ill. Catalogue 132 of Imperial oxy-acetylene apparatus for welding and cutting. Examples of broken castings repaired are shown, which indicate some of the possibilities of the process. The cutting of structural steel is also shown and other illustrations which make the catalogue of interest to all concerned with the possible use of oxy-acetylene welding and cutting equipment.

Becker Milling Machine Co., Hyde Park, Boston, Mass. Catalogue on Becker vertical and horizontal millers, containing a detailed description of the belt- and motor-driven vertical millers, of which there are fourteen types and twenty-four sizes. Specifications are also given for Becker profilers, "Lincoln" type millers and plain horizontal millers. The book is illustrated with engravings of a very high grade, the most interesting ones showing close views of continuous milling on Becker machines.